DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY A. S. RUSSELL, M.C., D.Sc.

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THE MOUNT EVEREST EXPEDITION
View of Kangchenjunga as seen from Darjeeling
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Editorial Notes

I am going to allow correspondents to get a word in edgeways this month. One writes, " In your Editorial Notes in the March issue you mention the possibility of an expedition to climb Mount Everest. If it be not too late in the day, might I ask in all seriousness what is the use of such a climb? Does it do any good? Are the scientific results hoped for (I suppose the expedition is going to be a scientific one) worth the trouble and the expense? Barring the view, what does anyone expect to find at the top? Isn't it time that this kind of thing were looked upon by all decent people in the same light as attempts to reach the North and South Poles—namely, a pathological manifestation, or, in less technical language, a singularly futile waste of energy and good money? "

* * * * *

I do not agree with this view. If one went on tour, hired halls and delivered addresses on the value of science, what would one say? This, that every fact discovered, every conquest of our surroundings, is a step forward in the upward march of humanity. It may lead to great developments. Of course, it may not. The important thing, however, is that it *may*. All the discoveries of modern science are based on the patient work of those who have laboured to discover the secrets of nature without caring twopence whether or not they were of " practical value." No one should say to these men, " Do this particular thing; go in this particular direction; drop this, it is too expensive." All things must be tried; all avenues explored. After all, in this particular case, what is ten thousand pounds (the cost of the expedition)? It is not going to " burst " a wealthy nation like ours. And a score of men only out of a population of forty-five millions are being detached from, shall we say, utilitarian ends to pursue this new adventure. Should it fail, the world will still go on. Indeed, is it not true to say that the world, except in a material sense, would long ago have ceased had it not produced in all ages the men and women who could resolutely attack a difficult piece of work like the ascent of Everest?

* * * * *

The President of the Royal Geographical Society, as reported in the March issue of *The Geographical Journal* (p. 204), has expressed the same idea in better words: " I entirely agree with what Sir Ernest Shackleton said about the necessity of a spirit of adventure being behind these [Polar] expeditions. But I think that the two—the spirit of adventure and the pursuit of science—go admirably together, because when men of adventure go into these terrible places, they like to feel that all their efforts and all the hardships they undergo may result in the attainment of some knowledge which will be of real use to the human race. I suppose that it is the adventurous spirit which all scientific men need in their pursuits. Unless they had it behind them in their work, they would not get very far even in laboratories. After all, it is only a matter of time before all the items of knowledge do come in useful for ' the amelioration of the lot of mankind.' It may be sooner or it may be later, but in the long result the utility of each will be found. The human race will never be satisfied until it has completed its knowledge of its surroundings. We want to know everything about this planet, even its furthest confines, because we not only have to adapt ourselves to our surroundings, but in the true spirit of man we have to master them."

A correspondent in Castlereagh, County Roscommon, has sent me an interesting note concerning Peary's claim to have visited the North Pole. He is inclined to side with the American Senator, whose view on the subject I quoted in a previous issue, and gives his reasons for doing so. I once heard a man " settle " this problem from a comfortable seat before a gas-fire. He argued that Peary probably did not get there, but as he had tried several times unsuccessfully to reach the Pole, as he was very very anxious to do so, and as he knew that the expedition of 1909 must be his last, what was more natural than to say he got there whether he did or not ? It seems an unfair argument, but the man had studied the psychology of the whole affair—Peary's doing the last stage of the journey without a white companion, etc.—and that was his view. Whatever be the truth, there is no doubt that Peary was a great man, a resolute and adventurous discoverer. It might be interesting to quote Sir Clements Markham's opinion of the rival claims of Cook and Peary from *The Lands of Silence*,[1] a really excellent book on Arctic and Antarctic exploration which has just appeared. It seems to me very just and not too non-committal :

" Peary was preceded by a similar attempt, made with much smaller means, by his former colleague, Dr. Cook. . . . Dr. Cook had been ethnologist in Peary's first expedition, and had acquired the Eskimo language as spoken by the Arctic Highlanders. He had also served in the Belgian Antarctic expedition. . . . The final start was made on March 18, 1908, the travelling being difficult owing to the lines of hummocks caused by ice pressure and the lanes of water. On March 30 Cook sighted land to the westward in 84° 50′ N. which he named Bradley Land, but he did not alter his course to examine it. On April 21 he reports having taken a sun's meridian altitude, which gave a latitude of 89° 57′, but he must have been mistaken, both overrating his distances and failing to make sure of his direction by observations. He doubtless did make a long journey over the ice, in a more or less northerly direction ; but without observations to obtain true bearings, no reliance can be placed upon his positions.

* * * * *

" Cook's instruments were a sextant, and a glass artificial horizon adjusted by screws and spirit level. He also relied on shadow observations, and on an odometer fitted to his sledge. But there is no mention of any observations for true bearing of the sun, and that he made none is conclusively proved by the fact that in returning he was unable to follow his outward tracks. . . .

* * * * *

" On March 5 [1909] they [Peary and his party] came to a lane of open water, which detained them for several days owing to lack of means for crossing it. During five days Peary paced up and down deploring his luck. Afterwards they crossed seven lanes of water on young ice. Bartlett was the last to return, after taking an observation with the resulting latitude of 87° 46′ 49″ N. Thus 280 miles had been traversed in a month, and they were 133 miles from the Pole. The speed had been calculated at under fifteen miles a day.

* * * * *

" From this spot Peary went on for the Pole with only his negro servant and four Eskimos, five sledges and forty dogs. It was a great mistake to enter upon what he considered the most important part of his journey without any white companion, more especially as bearings and distances do not appear to have been ascertained by observations. For help in making these rough estimates, and for such observations as were taken, a colleague was imperatively necessary.

* * * * *

" Directly Peary parted from Bartlett, his estimated distances were more than doubled, and the course was assumed to be due north. Peary refers to the meridian of Cape Colombia as if he had never deviated from that meridian during the whole journey. Without such observations it would not be possible to keep on the same meridian. Yet after journeys during four days estimated at from twenty-five to thirty miles a day, a meridian altitude of the sun was taken which gave a latitude of 89° 25′ N., or 97 miles due north from the position where Bartlett observed. Without amplitude observations this would not be possible, so that there must be mistakes in the observations for this and subsequent meridian altitudes. The sun was very near the horizon at noon at that time of the year. The distances were, perhaps naturally, overestimated. Peary was very fortunate in being able to follow his tracks during his return journey, in spite of a furious gale which might have obliterated them."

* * * * *

Several correspondents have written me about one of the puzzles in Mr. Stewart's article in the March number—the one that seeks to show that a half-yearly rise of £10 is better financially than a yearly one of £40. This was stated to be a straightforward problem, not a catch. Opinions seem to be, however, that either it *is* a catch, or if not the half-yearly rise proposed is *not* better than the yearly one.

* * * * *

I quote as an example of the letters received from one sent me by a major in the Sappers : " The ' salary ' problem *does* contain a catch, or, alternatively, Mr. Stewart has not calculated the salaries in accordance

[1] Published by the Cambridge University Press, 45*s*.

with the data given. The original salary is given as £400 *per annum.* Any rise of salary given later (according to ordinary practice and failing a definite agreement otherwise) is an increase in the *rate* of salary, and *not* in the amount of actual cash paid at the time of the increase. The second half-yearly payment made should, therefore, not be £200 + £10, but (£400 + £10) ÷ 2 = £205, and the series of half-yearly payments should read :

" First year :

£200
£205
——
£405

" Second year :

£210
£215
——
£425

" Third year :

£220
£225
——
£445."

* * * * *

I agree that an employer might be tempted to interpret the bargain in this way. I think, nevertheless, it is a wrong interpretation. The problem stated that the employee was engaged at a salary which *commences* at the rate of £400 per annum. Correspondents have led themselves astray by assuming that the man must continue at this rate for the first year. But why should he ? What is a half-yearly rise at all unless it becomes operative every six months ? Several people think he should wait for the first rise till twelve months were up. But this is quite unfair. What would a man, engaged to receive an *annual* rise, think of his employer if he had to wait till the end of *two* years for it ? And why should the cash value of the rise be modified in the least ? A periodic rise of £10 surely means that in any length of time equal to that period the employee receives £10 more than in the preceding period. It seems to me, therefore, that the problem is quite straightforward and was correctly demonstrated by Mr. Stewart.

* * * * *

Apropos of my remarks on telepathy in the March issue, a correspondent sends me the following interesting letter :

" Dr. Paul Bousfield's ' Mr. X ' is the same gentleman who ' obliged ' by going out of the room in the ' parlour-games ' of our youth—the poker and the hairpin are old friends.

" There was another pastime of our youth which was on all-fours with the ' simple but illuminating description of telepathic power ' given by Dr. Bousfield in his book. It was much more interesting to fix upon some member of the congregation, during the sermon, than to listen to the discourse ; and, having ' fixed ' upon him, to make him turn his head in your direction.

* * * * *

" The writer and his sister have breakfast together almost daily, and have, during that meal, almost daily experiences of ' simultaneously ' mentioning either the same event or the same person.

" Our mother, who was an invalid for some ten years, and was practically in her bedroom for the whole of the time, had, by some means or other, the appearance of ' knowing ' what was going on around her without any possibility of having been ' informed.'

* * * * *

" On one occasion, in particular, we had notice to quit the house we were then living in. The notice was served, by post, in the morning ; but in the afternoon—much to my sister's surprise—my mother said to her, ' As we *have* to leave this house, I shall not be sorry—it will be a change.' Her hearing was defective, and her room was too far away for her to have heard any conversation in relation to the notice, and, fearing to trouble her, the notice had not been mentioned to her, or spoken of in her presence.

* * * * *

" The writer only gives these personal experiences as interesting parallels with the doings of ' Mr. X,' but, interesting though they may be, he still thinks that Bacon was not far wrong when he said :

" ' The human intellect, in those things which have once pleased it (either because those have been received and believed, or because they delight), draws also all other things to vote with and consent to those—and though the weight and multitude of contrary instances be the greater, yet either it does not observe them, or despises them, or draws distinctions, and so removes and rejects them—not without great and pernicious prejudice—in order that the authority of those previous conclusions may remain unshaken. And so he answered well, who, when the picture of those who had fulfilled their vows after escaping the peril of shipwreck were shown to him hung up in a temple, and he was pressed with the question, did he not after this acknowledge the Providence of the Gods, asked in his turn, " But where are they painted who, after vowing, perished ? " The same is the method of almost every superstition, as in astrology, in dreams, omens, judgments, and the like : in which men who take pleasure in such vanities as these attend to the event when it is a fulfilment : but where they fail (though it be much the more

frequent case), there they neglect the instance and pass it by.'[1]"

* * * * *

We have to offer our warmest congratulations to two of our contributors—Mr. W. L. Bragg, Professor of Physics in the University of Manchester, and Dr. A. H. Church, Lecturer in Botany in the University of Oxford—on being recommended recently for election into one of the goodliest fellowships on earth, that of the Royal Society.

* * * * *

Last month, by an oversight, I omitted to thank Prof. J. L. Myres, of New College, Oxford, for kindly lending me the three photographs of Greece which illustrated Prof. Halliday's article.

Vitamines, or Accessory Food Factors

By James England

In 1897, C. Eijkman, who was the medical officer of a prison in Java, found that the fowls belonging to the establishment showed symptoms of paralysis and died, with extensive degeneration of the peripheral nerves. These symptoms were strongly suggestive of the disease beri-beri, then prevalent among the patients of the institution, and, as the fowls were mainly fed upon the rice refuse of the establishment, a dietetic origin for the disorder in fowls and men was suggested.

For a long time it had been considered probable that some connection existed between the human disease beri-beri and a rice diet, although it was not prevalent among all the native tribes who subsisted principally upon that food. Investigations showed that those affected consumed what is known as "polished" rice. This consists of the grain steam-milled, whereby the outer skin is removed, and polished with talc between sheepskins. The process does not injure the rice as a diet, but removes the cuticle, or skin, and the germ, or embryo. In districts where these constituents are retained, or where domestic or native mills are used, thus rendering their separation much less complete, beri-beri does not occur.

Eijkman supplied his fowls with an aqueous extract of the skin and embryo of rice removed in the process of milling, and quickly effected a cure. He called this disease *polyneuritis gallinarum*, and further study of it established its physiological equivalence to human beri-beri.

It is now fairly conclusively proved that the disease can be prevented or cured in man by substituting whole rice, or that prepared in native mills, for the "polished" article.

In those days, disease was generally ascribed to positive agents, such as microbes, toxins, or other poisons. In cases where a deficiency of a food constituent, or an internal secretion, was indicated, the disease was ascribed to the absence of a corrective to deleterious conditions or substances. It is, therefore, not surprising that Eijkman should have suggested that the skin or pericarp and the embryo of the rice were necessary to neutralise the otherwise deleterious effect of a diet overrich in starch.

This theory of Eijkman's did little more than add to the list of substances which at that time were considered necessary for the proper nutrition of animals, including men. But Captain Cook, about the middle of the eighteenth century, was nearer to modern developments when he stated that fresh food, especially green vegetables, contained *something necessary to maintain health*, which was absent from the preserved food used during his voyages.

It has been for some time a fairly well accepted principle, even outside the medical profession, that the substances necessary for proper nutrition comprise proteins, fats, carbohydrates, and certain minerals. But Captain Cook's "something" has recently been proved to be necessary also.

Proteins are described by the chemist Victor von Richter as rather enigmatical bodies. They are entirely of organic origin—that is, derived by the agency of life—and form the principal constituents of the animal organism. They also occur in plants, chiefly in the seed, and in the gluten of wheat, the albumen or white of egg, and certain constituents of the yolk, of milk, and of blood.

Carbohydrates include such substances as sugars, gums, starches, and cellulose.

Fats include such substances as butter, cream, and many of those pieces of meat which the ordinary child usually puts on the edge of the plate as unpalatable.

Minerals necessary as food comprise common salt, and compounds containing phosphorus, iron, and calcium, with a few others in very small proportions.

It will be seen from these descriptions that the substances previously considered to be the sole necessaries are the principal constituents of human food, while the requisite proportions are generally maintained by the variety ingested. A deficiency of any of them was considered to be conducive to what is known as "deficiency diseases"—such, for instance, as scurvy, rickets, etc.—but it is probable that the diseases are more often

[1] Bacon, *Novum Organum*, Lib. I, Art. 46 (Kitchin's Translation).

—if not always—caused by a deficiency of that "something" which is now known as accessory food factors, or vitamines.

In 1881 Lunin stated that, in addition to the dietary units recognised at that time, other substances existed which were equally indispensable for life.

In 1906 F. G. Hopkins, Professor of Biochemistry in the University of Cambridge, wrote: "No animal can live upon a mixture of pure protein, fat, and carbohydrate, and even when the necessary inorganic material is carefully supplied, the animal still cannot flourish. The animal body is adjusted to live either upon plant tissue or other animals, and these contain countless substances other than the proteins, carbohydrates, and fats."

It was, however, not until early in 1914 that Casimir Funk issued a detailed and authoritative account of some newly discovered bodies, which he named vitamines, on the erroneous supposition that they were chemically related to ammonia, as indicated by the suffix "-amines." These bodies were stated to be necessary for the growth and preservation of life.

It is at present generally accepted that there are three distinct vitamines, or accessory food factors, as they are more correctly named. They are:

1. The Fat-soluble A or Antirachitic Factor.
2. The Water-soluble B or Antineuritic (Anti-beri-beri) Factor.
3. The Antiscorbutic Factor.

Their chemical constitution is at present unknown; but Funk, by chemical processes, obtained a crystalline substance melting at 233° C., for which he obtained the formula $C_{17}H_{20}O_7N_2$, while Hofmeister claims to have separated a vitamine of the formula $C_5H_{11}NO_2$. J. C. Drummond, however, suggests that, owing to the facility with which vitamines are "adsorbed," they may have been carried down by other precipitates in the process of their isolation and examined and estimated as such.

Notwithstanding the present ignorance respecting their chemical nature, a vast amount of work of an empirical, but none the less conclusive, character has been carried out. These experiments, performed on young and growing animals, were generally of a preventive or of a promotive character, followed by curative measures. In both cases the animals were fed with food well balanced in respect of proteins, etc., but from which vitamines were absent. In the one case preparations containing vitamines were supplied with the food, while in the other case the food was not so supplemented until a cure was thought necessary. The result of these experiments was that, in the absence of vitamines, the animals under experiment suffered from "deficiency diseases" and ultimately died, unless the vitamine preparation was administered in time, when a speedy cure was usually effected. The application of these results to human beings is based on the assumption that the causes of failure of nutrition of one kind of mammal would produce untoward results of some kind in other mammals, and most probably the results would differ only in degree. In this way, many foods were approximately standardised in respect of their vitamine or accessory factor content.

The following table indicates the values obtained in respect of a few substances:

Foodstuff.	A.	B.	C.
Butter, cod-liver oil	+++	o	
Cream, mutton and beef fat or suet, fish oil	++		
Lard, vegetable oils	o		
Lean meat (beef, mutton, etc.)	+	+	+
Liver	++	++	+
Kidney, heart	++	+	
Brain, sweetbreads	+	++	
Fish (white)	o	?	
,, (fat), salmon, herring, etc.	++	?	
,, roe	+	++	
Tinned meats	?	V.S.	o
Milk, cow's, whole raw	++	+	+
,, ,, skimmed	o	+	+
,, ,, dried whole	+	+	V.S.
,, ,, boiled		+	V.S.
Cheese, whole-milk	+		
,, skimmed-milk	o		
Eggs, fresh and dried	++	+++	?
Wheat, whole-grain, other cereals generally	+	+	o
White wheaten flour, cornflour, polished rice	o	o	o
Germinated pulses and cereals	+	++	++
Cabbage, fresh, raw	++	+	+++
,, ,, cooked		+	+
Potatoes, raw	+	+	
,, cooked			+
Orange juice, fresh; swede, raw, expressed juice; lemon juice, fresh			+++
Lemon juice, preserved; lime juice, fresh			++
Lime juice preserved			V.S.
Vegetables and fruit generally	+	+	+
Yeast	?	+++	o
Meat extract	o	o	o
Beer		o	o
Honey		+	

A represents the Fat-soluble A or Antirachitic Factor.

B represents the Water-soluble B or Antineuritic (Anti-beri-beri) Factor.

C represents the Antiscorbutic Factor.

+, ++, +++ indicate the relative presence of the factor in three degrees.

o indicates their absence.

? indicates doubt as to their presence.

V.S. indicates a very slight quantity, less than +.

Where no indication is given in the various columns, no estimation was made.

Note.—The information in this table is extracted by permission of the Medical Research Committee from a more extensive list in the Report mentioned at the end of this article.

68
20
88

14
0

It may be accepted as a general statement that fresh animal and vegetable food, before treatment of any kind—but including butter and whole-milk cheese—usually contains the fat-soluble A and water-soluble B factors, while the antiscorbutic factor is not quite so generally or abundantly present, except in the juice of many kinds of fresh fruit and in cabbage. Potatoes form one of the cheapest and most practical sources of vitamines.

In the present stage of the theory very many more or less conflicting opinions have been expressed respecting vitamines and their susceptibility to change or destruction under varying conditions, so that it is probably unwise to generalise. It may, however, be safely inferred from the table of results that fresh food in its natural condition is more conducive to growth and health than the manufactured and ofttimes sophisticated article, however palatable it may be. Further, that excessive cooking is prejudicial to the vitamine-content of the food, since vitamines are somewhat readily destroyed at temperatures above 100° C., especially in alkaline reactions. It also appears from experiments that free oxidation during heating is conducive to their destruction. They are more stable in acid mediums, hence the value of lemon juice, oranges, and many other fruits.

It would appear as though nature had furnished human beings with an appetite instinctive for food containing the full complement of vitamines, and that civilisation has been doing her best to eradicate that instinct, to the detriment of the human race. And if instinct, operating through the taste, means anything in respect of food, it surely should be considered, in the natural and healthy individual, as prompting a selective action for those kinds which contain the special factors provided by nature for growth and health.

Moreover, the theory confirms certain prevalent dietetic principles. It does not depose cod-liver oil, fresh fruit, green vegetables, milk, or fresh meat. It certainly advocates less highly cooked food, and in that respect it is supported by dentists, who refer the modern inferiority of teeth to their diminished use on account of the highly cooked—and therefore softer—condition of present-day food.

In one direction it does certainly advocate a complete revolution, and that is in the case of cereals. It is not the first time that wholemeal bread has been advocated, but what was little more than a predilection before is now supported by a well-founded theory.

A short description of the various parts of a grain of wheat may perhaps serve to remove the odium attaching to wholemeal flour and bread created by the unfortunate use of the word "offal" in connection with those portions of the wheat rejected during milling. At the same time, it may afford some insight into the structure of cereals generally.

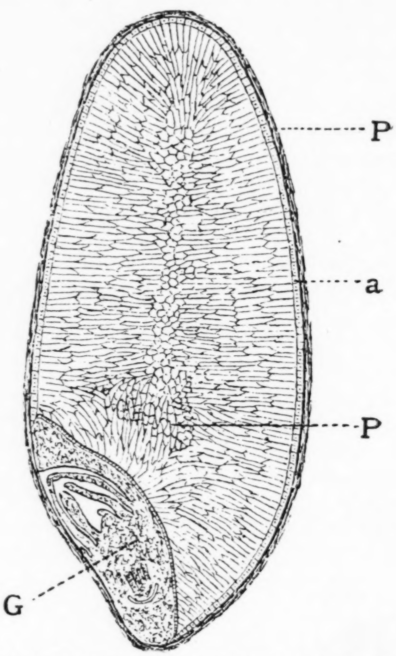

FIG. 1.—LONGITUDINAL SECTION THROUGH A WHEAT GRAIN. FOR SIMPLICITY, THE CREASE IS NOT INDICATED.

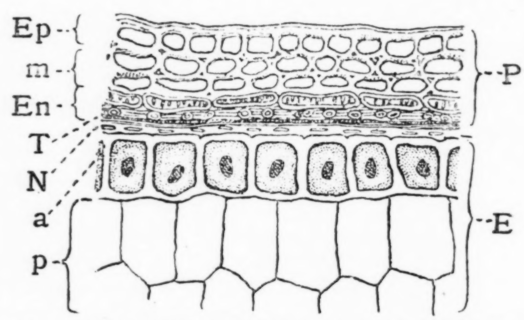

FIG. 2.—CROSS-SECTION THROUGH THE BRANNY ENVELOPE AND OUTER PORTION OF THE ENDOSPERM OF THE GRAIN MAGNIFIED ABOUT 160 TIMES.

The references for both figures are:

P. Pericarp forming with (T) the testa and (N) the nucellus the branny envelope of the grain, and comprising:

ep. Epicarp; *m.* Mesocarp; *en.* Endocarp.

N. Nucellus.

T. Testa.

E. Endosperm, comprising:

a. Aleurone cells; *p.* Parenchymatous cells.

G. Germ or embryo.

As indicated by the diagrams, the grain is surrounded by a series of tough cellular envelopes, which are removed by the miller as completely as possible to produce the whitest or "patent" grade flour. This grade therefore consists principally of the milled parenchymatous cells (*p*) of the endosperm. The other grades of flour contain varying proportions of the skins of the grain and the germ, with wholemeal flour at the other end of the grading, which should contain the entire grain with the germ. The germ is the richest in vitamines, and is said to impart a pleasant, nutty flavour to bread. The aleurone layer is the next in importance as regards vitamine-content.

From what has been mentioned about underdone food, it might be inferred that, in the process of baking, the vitamines in wholemeal dough would be destroyed by heat in the oven. Such is, probably, the case to some extent, but it is also probable that the crust towards the end of the process forms a protective coating which keeps the interior moist, and thus prevents any serious rise in temperature above 100° C., even if it attains to that degree. There is little doubt that in these circumstances some proportion of the vitamines is preserved. In domestic cookery it is probable that a larger proportion remains intact.

As long ago as 1911, Dr. J. M. Hamil reported to the Local Government Board that in bread made from the "entire" wheat class "the presence of the offal, including the germ, secures a somewhat larger quantity of mineral matter and of suitably combined phosphorus or *other substances*, as yet unknown, which may prove to be of importance." The italics are not used in Dr. Hamil's report. In order that no misunderstanding should arise respecting the mineral matter and combined phosphorus, he states that they "possibly may be necessary for health" in the case of children. It is probable that they are necessary for adults also; at any rate, there is nothing about them that suggests "offal" in the usual meaning of the word, since, comparatively, they largely enter into the composition of many foodstuffs.

There are, however, serious, but not insurmountable, objections to the use of wholemeal flour. It is stated by millers that the germ adversely affects the keeping qualities of flour; but the modern methods of milling and the use of sound grain probably synchronise with the improved keeping qualities of flour nowadays, and thus remove any blame from the germ as affecting keeping qualities. Experiments indicate that wholemeal flour remains in good condition if the moisture be not excessive.

The baker states that the germ in flour affects the strength and stability of the dough, while wholemeal flour absorbs less water and does not produce such a large loaf or such white bread as the highest grades of flour. The quality of the dough could no doubt be improved if necessary, as a result of research into the matter, or even by the omission of one or more of the other ingredients usually introduced by the baker. The absorption of water and the size of the loaf are probably inconsiderable factors, except from the point of view of the baker, who would eventually find means of recouping himself for any loss occasioned by the use of wholemeal flour. But colour is everything! It is respect for that quality which induces people to use bicarbonate of soda in cooking greens, and thereby reduce the vitamine-content of an ample and economical supply. For this reason, all kinds of sophistication of food are condoned, even the use of poisonous sulphate of copper used in preserved green peas. The objections to wholemeal bread, on account of a growing appreciation for science, may eventually be removed, and its superior dietetic qualities be recognised with beneficial results.

On account of our ignorance of the chemistry of vitamines, they have not yet been successfully isolated; therefore, neither their constitution nor their appearance is known. It is no very extravagant thought to visualise them as the connecting-link between inanimate and living matter; but at present it would appear from tentative attempts at their isolation that they, or their compounds, are crystallisable bodies.

It has been proved by experiment that they are indispensable to life, and no diet is complete without them. In their continued absence, the muscles eventually dwindle, the nerves degenerate, heart and bone become affected, and a predisposition to tuberculosis subvenes.

They are believed to be solely manufactured by vegetable life, whence they pass into animals. Although not credited with nutritive qualities themselves, there is strong evidence of their decomposition, or of change in their constitution in the animal system, on account of their continuous supply being necessary for the proper nourishment of the body by the food ingested. Funk regards them as the mother substance of ferments and hormones, and of vital importance to the thyroid and other ductless glands. It has also been advanced that their action is catalytic—that is, that they induce the change in the food necessary for its proper assimilation, without themselves undergoing change. Although theoretically a catalyst is unaffected by the reaction it induces, yet, on account of the almost unpreventable presence of foreign bodies or impurities, in most cases other reactions take place during catalysis, and thus modify the catalyst itself. On this account, its action is hindered and finally arrested. Such is very probably the action of vitamines in animal systems, and thus their constant renewal is necessary. This is all the more probable because, when

animals are deprived of vitamines, the progress of their disorder is very slow at first, with later acceleration, and their recovery rapidly follows the administration of the accessory food factors.

On account of their infinitely small proportions in food, it is no matter for surprise that vitamines have so long eluded the vigilance of the chemist during researches in connection with food. As a contrast to the vast magnitudes forced upon our consideration during the war, and since then—even painfully—by the Chancellor of the Exchequer, Science has been teaching the importance of the infinitely small; and when one considers the enormous injury that a few imperceptible microbes can effect in the human system, it is but reasonable to acknowledge that an equally small or slightly greater quantity of a substance may be not only beneficial, but absolutely necessary to health.

NOTE.—It has been possible to give no more than a very brief outline of the subject here, but for those desirous of proceeding further the *Report on the Present State of Knowledge concerning Accessory Food Factors* (*Vitamines*) to the Medical Research Committee, Special Report Series No. 38, published by H.M. Stationery Office, 1919, price 4*s*., can be thoroughly recommended. The book—unlike most Government publications—is quite understandable, since it is written in a lucid style, with few technicalities. It also contains a long list of other important publications on the subject which would prove invaluable to the student. More recently a discussion of the subject was published in the *British Medical Journal* for July 31, 1920, price 6*d*.; and Dr. J. M. Hamil's *Report to the Local Government Board on the Nutritive Value of Bread made from Different Varieties of Wheat Flour* (H.M. Stationery Office, 1911, price 3*d*.), although not dealing with accessory food factors, affords useful information in connection therewith.

The Undiscovered North

By J. M. Wordie, M.A.

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THE Arctic problem of most moment to mankind has never been the actual reaching of the Pole itself. The objective of the early explorers was a practical one—the investigation of a North-West Passage to China: when that was found impracticable, scientifically-directed exploration would have turned its attention to the possibility of discovering new land in the unexplored Polar Basin. Both the " man in the street," who supplied the weight of public opinion, and the wealthy supporter, who has so often supplied the necessary funds, which have respectively made public and private exploration possible, have, however, had their minds and imaginations filled rather with the idea of planting a national flag at the summit of the earth. It is through this fact that at the present day modern geographers are disgraced by the continued existence of a huge unexplored tract about the North Pole, which may or may not contain notable land areas.

The Pole itself, not quite in the centre of that basin, has probably been reached—by Cook or by Peary, or by both ; though the possibility still remains that neither actually reached the goal. Whatever be the truth, the results of these two expeditions are equally meagre and valueless : it is quite clear that neither Peary nor Cook were scientific observers either by instinct or by training. In this respect they compare most unfavourably, for instance, with Captain Scott in the Antarctic and the long list of British naval officers who explored Arctic Canada in the fifties of last century. The bitter controversy between Cook and Peary, the natural aversion thus engendered, and the poorness of their results are in marked contrast to the popular applause which greeted Shackleton back from the Antarctic about the same time with results and observations exceptional both in quantity and in quality. For these and other reasons the public of to-day regards the Antarctic rather than the Arctic as the explorers' main field. In the last generation only one British expedition, the Canadian Arctic Expedition under Stefansson, has tried to penetrate the unknown Arctic, whilst since 1900 hardly a year has gone by without one or more parties wintering in the Antarctic.

Yet in the Arctic, as much as in the Antarctic, a really big discovery may be made. There is still a possibility of finding a new land, perhaps as big as Britain, in or near that part of the Arctic Ocean called the Beaufort Sea. Whoever is fortunate enough to find such a landmass will have made the last great Arctic discovery.

The arguments for and against the occurrence of land are many and evidence of many descriptions has been cited on either side ; but, as has so often been the case in other geographical problems, most of the deductions put forward have little real weight. Appeal, for instance, is made to legends of Alaskan Eskimo about land to the north ; but who can tell whether these stories have originated where the Eskimo now live or whether they were brought by their ancestors from elsewhere ? Flights of birds are constantly seen going north from the Alaskan coast, and these migrations may have a little more value ; on the other hand, it is quite possible that their objective is simply some portion of the Parry Archipelago. Then there have been from time to time definite statements made by whalers and explorers to the effect that they have actually seen land ; these, however, have not so far survived further investigation : notable examples were the so-called " Crocker Land," which MacMillan wiped off the map in 1914, and " Keenan Land," dealt with in similar fashion by Storkersen in 1918.

Reasons based on the nature of the pack-ice found round the margins of the unexplored area cannot be dismissed quite so easily. Yet there is perhaps no more unsound argument; for heavy pack is used by the protagonist of one party (MacMillan) as practically proving obstructing land, while other authorities (e.g. Nansen) draw from it an exactly opposite conclusion. In this connection, it should be stated that there is no more untrustworthy guide to the nature of the pack-ice than the popular accounts of the expeditions sent out to search for Sir John Franklin: travellers' tales are a byword, and have certainly lived up to their reputation in the matter of pack-ice. Matters were also made worse through members of the Nares Expedition of 1875 arguing for a "palæocrystic sea" of unknown antiquity. Few reliable records, in fact, of the thickness of the ice exist before the development of the camera and its application to Arctic work provided a method of standardisation which, when used scientifically as opposed to artistically, does not lie. To-day no one believes in a "palæocrystic sea"; and any scientist wishing to argue about the Arctic pack can refer to Nansen's *Farthest North*, where he will find that the heaviest normal ice the latter met with is not more than five years old. Nansen qualifies his statement by limiting its application to the ice found along the *Fram* track. The fact is probably, however, of universal application: for none of the photographs accompanying MacMillan's, Stefansson's and Storkersen's articles show anything widely different from the five-year Arctic floes or even from the two- to three-year Antarctic pack.

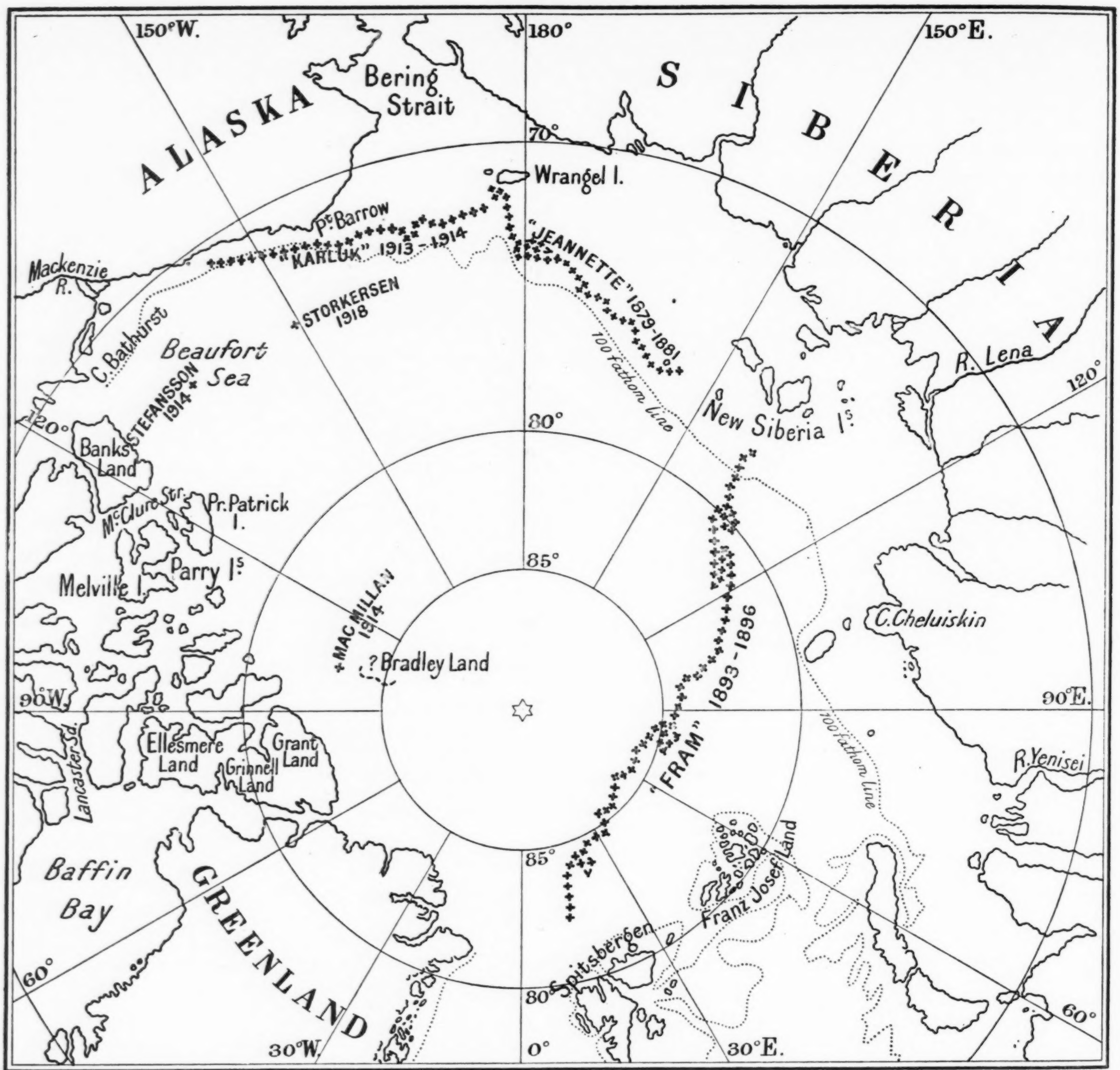
Nansen has not only shattered theories built on the nature of the ice, but has also invalidated to a great extent those built on tidal and current phenomena, which are by some regarded as still more convincing. One writer in America, basing his hypothesis on oceanographical grounds, has even drawn a map with the supposed land marked in. Exploration since then has only touched the fringe of the debatable area, snipping off small pieces from the margin of this hypothetical polar land. Nansen, however, strikes at the very heart of the theory, pointing out most forcibly that the present tidal observations are contradictory; they are therefore quite useless for arriving at any such general conclusion, and likely to be misleading if so employed.

There are, in fact, only two lines of evidence which are in any way reliable. The first of these is the position of the edge of the so-called continental shelf; the other is based on the drifts of various ships caught in the ice. The edge of the continental shelf is taken as the 100-fathom contour of the sea bottom. It is found in practice that this line approximately encloses a wide area of shallow water round all the continents, and that the transition from this to oceanic depths is a sudden one. Known Arctic lands are all situated on a shelf of this nature; and beyond it Nansen has proved the existence of depths of over 1,000 fathoms, which probably prevail over a large part of the Polar Basin. With the exception of a few isolated islands of volcanic and coral origin in the southern seas, it is contrary to all experience to find lands arising from oceanic depths. One can therefore say that, if the boundary of the continental shelf were completely known round the Arctic Ocean, it would be quite justifiable to infer that there was no large mass of undiscovered land in the Polar Basin. This, however, is very far from being the state of our knowledge. On the accompanying sketch-map a dotted line shows roughly the 100-fathom limit north of Alaska and Siberia. It is based on a relatively small number of observations, and it is quite likely that subsequent exploration will cause big corrections to be made to it. North of the Beaufort Sea, however, there are no observations at all, and it is just here, where the position of the outer edge of the continental shelf is unknown, that land may exist.

The drifts of vessels in the ice supply very positive information. The *Karluk* (1913–14), *Jeannette* (1879–81) and *Fram* (1893–96) tracks are almost a continuation one of another. They do not represent so much the route of a true current as the mean wind directions from point to point; and, moreover, the ice does not drift directly before the wind, but 15°–20° to the right. They show, in fact, a wind-drift which can be paralleled in all the other oceans. It is surely a stroke of good fortune that the only three drifts on record should link up one with another to form an almost continuous curve round the unexplored area. It goes without saying that, given the continuance of present meteorological conditions, any other ships will be certain to follow more or less closely this extraordinary line.

An interesting piece of evidence in connection with the above is afforded by the drift of some of a large number of casks which were placed on the ice north of Canada and Alaska twenty years ago. Of these only two have yet been located, one of them having travelled from Point Barrow to Iceland in six years, the other from Point Bathurst to the north of Norway in eight years. Very likely both followed the *Karluk-Jeannette-Fram* track: the first, however, did not travel down the Greenland coast to Cape Farewell, as did the *Jeannette* wreckage, but, being farther off the coast, was deflected to Iceland; the second was presumably also somewhere near Iceland when it got caught in the Gulf Stream Drift and carried north again to the north of Norway.

The East Greenland Current is a continuation of the Arctic Drift, but its rate is three to four times as fast as the movement of the ice in the Polar Basin, where the



Stanford's Geog.l Estabt.

rate found by Nansen averaged about one mile per day. The relation between the Greenland Current and the Polar Basin is therefore similar to that between a mill-race and a sluggish pond which it drains. To keep the race fed a big gathering-ground is necessary: and it is therefore a fair deduction that the bigger part of the unexplored area is likely to be ice-covered sea.

This is the state of knowledge about the Polar Basin; and sporadic attempts have already been made to find the new land. To Mikkelsen and Leffingwell belongs the credit of first venturing out (in 1907) from the Alaskan coast on to the polar ice, though their journey was hardly long enough to give definite results. Stefansson's wonderful trip from Martin Point in Alaska to Banks Land in 1914 was a much longer journey, but is just as inconclusive. On the information gained, however, he arranged for one of his men, Storkersen, to make a still longer trip. Storkersen sledged out about 150 miles from the Alaskan coast in April 1918; and then lived on a drifting floe for six months. His observations show that there is little or no true current: the wind is the controlling factor, and under its influence he zigzagged back and forwards for a long time over the same ground, just as did the *Jeannette* and the *Fram* during their drifts. Then, unfortunately, before any conclusion could be arrived at as to the direction of the drift, Storkersen had to return owing to ill-health. Among other things, however, he brought

back a large number of reliable soundings, and once and for all removed the so-called "Keenan Land" from the map. Incidentally Stefansson and Storkersen made one very notable discovery, namely, that it is possible to "live on the land" even on the drifting pack-ice—at least in the Beaufort Sea area.

One other expedition on to the polar pack deserves mention, namely MacMillan's journey in 1914 to try to find "Crocker Land"; he travelled at a surprisingly good rate over the ice, and very soon proved that there was no "Crocker Land." Then, probably owing to dog trouble, he turned back, when to all appearance he had a clear field either to go right ahead, or else, by turning in a more northerly direction, to verify or disprove the existence of Dr. Cook's "Bradley Land" in 84°–85° N.

Neither soundings nor the drift of ships, nor the reports of travellers on the pack-ice, show evidence against possible land north-west of the Parry Archipelago. On the whole the balance of evidence, particularly the big feeding-ground necessary to supply the ice carried by the Greenland Current, suggests that the land, if present, is not of very large size. Like many another problem, the only practicable method of solution is to "Go and see." This is what Amundsen is doing at the present time: for he hopes to drift across the Polar Basin in the same way as the *Fram*, but in higher latitudes, that is to say nearer the Pole. In the last telegram received (dated August 1920) he was forging into the pack north of Bering Strait, but with a crew of only four men all told. Should he get well within the *Karluk-Jeannette* track, the chances are that he will finally drift very close to the Pole itself. Ships have indeed sailed as far north in this quarter as approximately 74° N. It is much more likely, however, that he will be caught in the ice and start drifting before a really high latitude is reached. In that event new geographical results will only be obtainable if he leaves his ship, a course the small size of his crew is likely to prevent him from adopting, unless the ship is crushed and he has to leave it perforce. If the latter situation should arise, it is to be hoped that he will be able to sledge across to Grant Land (where a depot of provisions has been laid for him) either via the Pole itself or via "Bradley Land." Of the two journeys the latter is the more desirable from the geographical point of view. The existence or non-existence of "Bradley Land" is the touchstone for testing Dr. Cook's claims to have reached the North Pole. If land does not exist, his case is demolished for ever. A photograph of what is undoubtedly high mountainous land is given in Dr. Cook's book and is labelled "Bradley Land"; and the letterpress is equally unambiguous. Judgment on Cook should therefore be reserved till his statements have been confirmed or refuted.

It may be said, perhaps, that the search for new land north of the Beaufort Sea might well be held over until Amundsen returns. This is not so; Amundsen's track cannot pass anywhere near the one likely area where the edge of the continental shelf is neither known nor to be inferred with any certainty. The chances of making a successful attack may be considered as good. Ships have reached both Banks Island and Melville Island, though neither of these is quite near enough to the final objective. An effort should be made to reach Prince Patrick Island in a motor sloop of 50–100 tons; Winter Harbour on Melville Island was not difficult to reach from Baffin Bay a century ago under sail alone; surely ships of to-day can better that record? If the sloop gets held up, a whaleboat or cutter should be able to reach and establish a base even on Prince Patrick Island. The latter is the ideal jumping-off ground for a sledge journey north-westwards for 400–500 miles, a journey which will either result in the location of new land or settle finally the last important Arctic problem.

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Maritime Wireless

By Lieut.-Col. C. G. Crawley, M.I.E.E.

THE first, and still by far the most important, application of wireless signalling was for communication with ships; in fact, even yet there are no regulations governing international wireless working except those contained in the International Radiotelegraph Convention of 1912, which deals only with ship communications.

So far as these communications are concerned, the wireless telephone is in no greater use to-day than it was nine years ago; but in the case of aircraft it forms the principal means of communication with the ground, and between the aircraft themselves. This is largely due to the fact that most aircraft can ill afford to carry a trained telegraphist to do work which can be done, though on a more limited scale, by the pilot himself making use of a wireless telephone.

Before long, no doubt, the wireless telephone will come into more extensive use for maritime communications, but for some time to come it is likely to remain as much a luxury for ships as the telegraph is for aircraft. The great advantage of the telegraph over the telephone is that much longer ranges can be obtained for the same expenditure of electrical energy, and the great disadvantage is that a telegraphist is required to work the apparatus, though it must be remembered that even the operation of a wireless telephone requires a certain amount of training. There is an obvious future for telephony in ships when arrangements can be made for communication through land stations direct with subscribers on the telephone system of the country; but we had better confine ourselves to the present time, when, as a matter of fact, such arrangements are not in operation, and wireless telephony is not used for ship and shore communications. On the other hand, wireless telegraphy is now universally recognised as an essential fitting for the safety of life at sea, and in this country has recently been made compulsory for all sea-going ships which are passenger steamers, or ships of 1,600 tons gross tonnage or upwards. This includes over 3,000 British ships. In vessels carrying 200 or more persons, three operators are normally carried, and a continuous watch is kept. In those with 50 to 200 persons, continuous watch is also kept, one operator and at least two "watchers" being carried; and in the remaining ships watch is kept for eight hours daily at specified times, one operator only being carried. The qualifications required in the case of a watcher are such as to ensure his recognising the general distress call and the safety signal. Should he hear either of these calls, he turns over the watch to a skilled operator. Any person in the ship, if so qualified, may act as a watcher.

In this country the Post Office issues licences to ships in respect of their installations, and certificates to operators and watchers who qualify at examinations conducted by that Department. The land stations for communication with ships (see map) are all worked by the Post Office, with the exception of the station at Poldhu, which is used partly for broadcasting Press and other messages to ships, that is, sending out messages without receiving replies. This station is worked by the Marconi Company. The station at Devizes is fitted with continuous wave apparatus, and communicates up to distances of about 1,000 miles, on a special wave-length of 2,100 metres, with such of the large liners as are similarly fitted in addition to their compulsorily-fitted installations. The other stations use spark apparatus similar to that compulsorily fitted in ships, and keep watch on the 600 metres wave, which is that used for distress messages and, in fact, for practically all messages sent by ships, with the exception of the long-distance traffic mentioned above. The compulsorily-fitted installation must be capable of communicating with a standard Post Office station up to at least 150 miles, but communication up to 200 or 300 miles is usually obtained according to the power of the installation fitted.

As a general rule, ships keep watch with their receiving apparatus adjusted for the reception of the 600 metres wave, and are thus ready to receive any message of distress from a ship within range or a call from a ship or land station. The wave-length of 600 metres was detailed for this purpose in the 1912 Convention, as it is a very suitable wave for transmission from ships of average size, and it was very necessary to lay down some one definite wave on which distress messages would be sent, and would have as good a chance as possible of being received by all ships and land stations within range. A distress message is preceded by a signal consisting of three dots, three dashes, and three dots sent as one sign, and repeated at short intervals. This is usually alluded to as the S.O.S. signal, though the letters S.O.S. sent as a group in the Morse Code is not really the same as the distress signal which is sent as one sign. When this signal is received all communication ceases, except that consequent upon the call for help. The safety signal consists of three dashes repeated ten times at short intervals, and is sent as a preliminary to information of an urgent character involving the safety of navigation, e.g. icebergs, derelicts, cyclones, etc. The idea of adopting some such warning signal resulted from the inquiry into the loss of the liner *Titanic*, which struck an iceberg and sank on April 15, 1912. In this case the S.O.S. signal was responsible for saving over 700 lives, and if a safety signal had been in general use, it is quite likely that the whole terrible disaster would never have occurred.

It is hoped that before long satisfactory automatic apparatus for registering the distress signal will be devised, in which case it is laid down that British ships, now only compelled to carry one operator, shall also be fitted with this apparatus, and ships which carry watchers as well as an operator may substitute the apparatus for the watchers.

The international regulations framed at the 1912 Convention for maritime wireless signalling are still in force, but are in much need of the revision which normally would have taken place three years ago, and which it is hoped may be arranged for this year, as the great strides made in wireless practice during the war have naturally overstepped the somewhat restricted boundaries of the Convention.

As a matter of fact, the apparatus used in merchant ships was much the same at the end of the war as at

the beginning. All the great developments had taken place in naval, military, and air force stations, both mobile and fixed, and little time was left for improving the design of apparatus for the mercantile marine. As soon as the war was over, however, the technical lessons gained were quickly applied to the design of ships' sets. Old sets have now been overhauled, and when new ones are installed, their all-round efficiency is far in advance of the pre-war type. In many of the larger passenger steamers a long-range set, using either the Valve or the Arc System, is being fitted, in addition to the Spark set, and altogether the technical arrangements are rapidly being brought into line with the improvements made in the naval ship sets during the war. Many naval requirements are, of course, not applicable to the mercantile marine; in fact, the technical lines of development in the two services can never run on exactly parallel lines, as a warship is normally required to fit in for communication purposes with a fleet in close touch, several ships of which may be signalling simultaneously on different wave-lengths; whereas a merchant ship is normally acting as a more or less isolated unit, always ready to receive a distress call on the 600 metres wave-length from any ship at extreme range. This means that for a warship very selective apparatus is an absolute essential, and it can be readily arranged, as a navy is a small unit where control is easy; but in the merchant service great selectivity may often be a distinct disadvantage, as calls from ships not accurately adjusted to the wave-length intended may be missed, and it is impossible at present to ensure that the apparatus in all ships of all nations shall be accurately adjusted. Selectivity, like Free Trade, is excellent if everyone else adopts it.

Besides long-distance continuous wave sets, with the possibility of telephony in the background, the important advent of directional apparatus must be noted. The wireless "direction finder" is becoming of recognised value in navigation when other means fail, as in fog. The apparatus is fitted in the wireless office and is worked by the wireless operator. With this apparatus the operator can obtain the bearing of a wireless station relative to the fore and aft line of the ship, and the actual position of the ship can be obtained by the intersection of bearings from two or more stations. Up to about 100 miles the bearings as set off on the Mercator's chart are accurate enough for all practical purposes, but for greater distances conversion tables or charts on the gnomonic projection must be used. In these charts great circles appear as straight lines instead of as curves, as in the case of Mercator's, and the fact that such charts are required for long distances will be evident when it is remembered that wireless waves travel along great circles over the surface of the globe. Usually the bearings obtained are correct within two degrees, and greater accuracy is not often required; but errors mostly due to the bending effects experienced by wireless waves, especially at night, do sometimes give trouble. A number of ships have been fitted with this direction-finding apparatus, and have often proved its utility as an aid to navigation in thick weather. There are some Government stations designed and used solely for the purpose of giving bearings to ships. In these cases the station takes a bearing by receiving signals transmitted from the ship, and communicates them to the ship. The results are as a rule more accurate than those obtained by having the directional apparatus in the ship; but the advantage of the ship itself being able to obtain its bearing from any ordinary station within range is so great that the present tendency seems to be to increase the number of ships fitted rather than the number of stations. Another advantage of having the apparatus on board is that in foggy weather it may be used for obtaining the direction of another ship fitted with wireless. Advances are also being made with directional transmission—that is, the transmission of wireless waves in one direction only, instead of the usual all-round radiation—an arrangement obviously of great value for navigational purposes.

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It may be considered, therefore, that wireless in the mercantile marine, if it made no great technical advances in the war, is now progressing so rapidly that it will soon be as up-to-date in every respect as its supreme importance demands. For point-to-point communication there may be, and indeed there is, much discussion as to the relative merits of wireless and line working, but for ship and aircraft there can be no discussion: it is just wireless or nothing.

The Mooring and Handling of Airships on the Ground

By Major George Whale (Late R.A.F.)

The accident to the rigid airship R34, which culminated in her total destruction on the night of January 29, has emphasised the necessity for providing more efficient methods of handling these large vessels on the ground and mooring them in the open.

It will be remembered that R34, although damaged in flight by striking a hill to the extent of disabling three out of five engines, arrived to all intents and purposes intact over the landing-ground of her base at Howden.

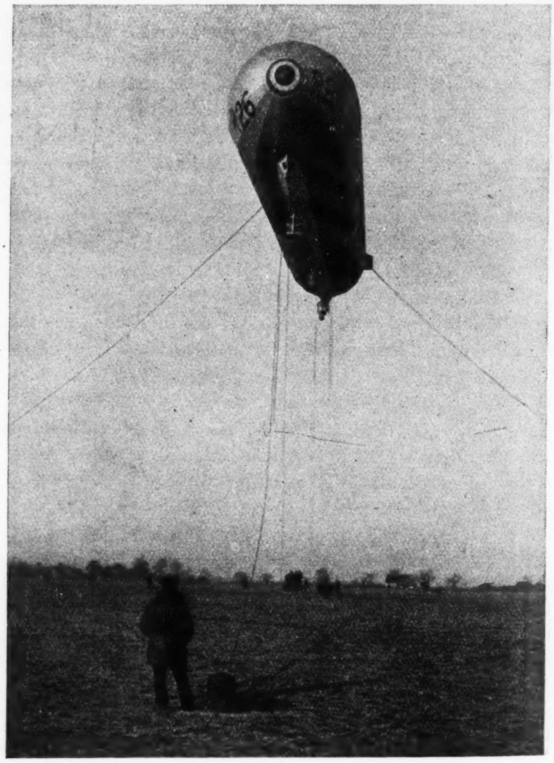
While attempting to take the ship into the shed under man-power, the initial serious damage was sustained by the forward car bumping on the ground. This was caused by the ship becoming unmanageable owing to the force of the wind. She was accordingly taken back to the landing-ground to be moored out by a method known as the three-wire system, which will be described in due course. The forward part of the hull structure having sustained damage, the airship rode badly at her moorings, and threatened to break up. A second abortive attempt was made to enter the shed, which caused still further damage, and the ship afterwards became a complete wreck.

It is therefore apparent that man-power is insufficient to house a large airship in a shed under unfavourable weather conditions, and that the three-wire system of mooring is by no means to be depended on.

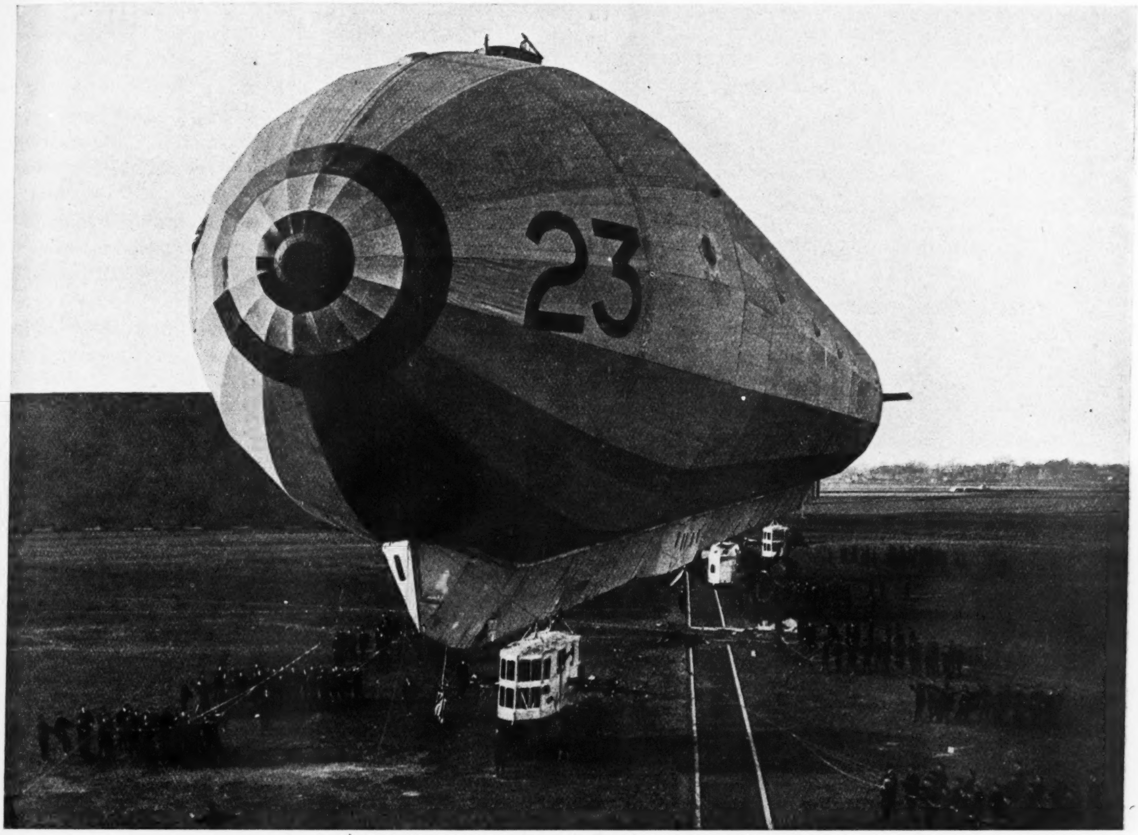
In this country, experiments have been conducted in towing airships by means of tractors to supplement man-power, but the results of these did not come up to expectations. In practice it was found that the tractors, owing to the uneven surface or slipperiness of the ground, advanced in a series of jerks, which imparted an uneven strain upon the towing cables. The tractors used—of which, perhaps, the army tank was found most suitable—were, admittedly, not designed for the work in hand.

The Germans, on the other hand, have made a standard practice of handling airships with the assistance of trollies and track rails, which, as far as can be ascertained, has proved highly satisfactory in their country.

The tracks, consisting of three rails each, are laid down through the shed and extend beyond for some considerable distance at either end. The two outer rails are flanged at the top and bottom and are set vertically, the centre one being laid horizontally. By this means the trollies are able to withstand both upward and lateral forces, which may be transmitted by the airship. The airship, having been landed as near to the rails as is possible, is "walked" by man-power towards the shed. When the forward part of the ship is over the rails, the handling guys are made fast to the trollies, when the towing process commences; as the after-part of the ship reaches the track, the same process is repeated, and the ship can be dragged into the shed by a very small number of men.



RIGID AIRSHIP MOORED OUT BY THREE-WIRE SYSTEM. THE THREE MOORING CABLES ARE SHOWN, ALSO THE MOORING BOLLARD.



RIGID AIRSHIP R23 LEAVING SHED FOR TRIAL FLIGHT.

It is conceivable that, if the shed at Howden had been equipped with similar rails, R34 might have been housed without accident.

The difficulties attendant on taking airships in and out of sheds in any but favourable weather conditions are so great as to render this type of aircraft practically useless for commercial purposes, where a reasonable regularity of flying is essential, unless some means of overcoming them is assured. The solution of this problem is undoubtedly mooring in the open.

Since the early days of airship history, experiments have been conducted in mooring out as an emergency method in the event of mechanical breakdown preventing an airship from returning to her base. These experiments have throughout followed two lines of thought—(1) mooring by means of cables; (2) mooring to a mast.

With regard to the former of these two methods, in the early days trials were made in mooring to a drogue by a single cable over water. The dragging motion of the drogue through the water was found to check to a great extent any tendency of the bow of the ship to move in a lateral direction. When moored, however, to a single point on land, it was found almost impossible to keep the airship head to wind. To correct this tendency to surge, the method was amplified by introducing three cables, which were led to the mooring-point of the ship. This system, known in its earlier stages as the "Usborne Method," from the name of its originator, has been developed into the present-day three-wire system, which was utilised with unfortunate results in the case of R34.

In this system three bollards are spaced at a considerable distance apart, and form in plan an equilateral triangle. To these are attached the three mooring cables taken up by the lift of the ship, which floats in the air at the apex of the pyramid so formed. When trimmed up by the bow, the airship will be found to ride satisfactorily, although there is always a tendency to "yaw." The disadvantages of the method are the difficulty of replenishing gas in rough weather, and the danger aforementioned of the ship getting off the wind. For these reasons, mooring by cables can

be considered only as an emergency method, and not to be relied upon in commercial flying.

Various experiments have also been conducted throughout airship history with the mooring mast. At Farnborough, Kingsnorth, and Wormwood Scrubbs, masts of different designs were tried, and gave promise of better results in the future. Towards the end of 1917, most satisfactory trials were carried out with a new design of mast, using a small non-rigid airship. Encouraged by these, a large mast was designed and manufactured for the mooring of rigid airships. In this case the ship was secured by the extreme nose into a specially constructed socket at the head of the mast. The structure revolves on roller bearings, and as the ship is held rigidly, there is no danger of her "paying off" before the wind.

Gas and water trunks are led to the top of the mast, and from thence into the hull structure of the ship, with the result that the difficulty of regassing or refuelling is eliminated entirely. The trials which have been held up to date are eminently satisfactory, and are continuing at present at Pulham Airship Station with R33 and an improved type of mast.

There seems every reason to anticipate that the mast will be a complete solution of the mooring problem, and at the same time of regular flying of airships. In the future, the shed will be entered only on the occasion of periodical refits, as the surface vessel enters a dry dock.

In the days to come, we can envisage the mooring mast transformed into a mooring tower equipped with lifts for passengers and cargo. The giant air liner will pick up her moorings as easily as the Cunarder on entering port. Water, oil, and fuel will be pumped into the ship through mains incorporated in the tower.

The whole future of the airship is at stake on the efforts of the technical staff now working at Pulham. For this reason, it may be hoped that whole-hearted support will be forthcoming to assist in bringing its efforts to a satisfactory conclusion.

A Textbook of Inorganic Chemistry. By J. R. PARTINGTON, M.B.E., D.Sc. (Macmillan, 25*s.* net.)

A thoroughly good book for University men. The price, however, is high. It supersedes the existing text-books of its class. Good diagrams and good printing. A number of slips have eluded the proof-reader. The parts of the subjects on which the author is an authority—Physical Chemistry, the Alkalies, etc.—are particularly well done. The idea adopted throughout of referring the atomic weights of elements to hydrogen as unity is a thoroughly bad one, and shows that the author does not appreciate recent work on radio-activity and on "isotopes." It should develop into a good second edition.

The Zeppelin Giant Monoplane

By E. Sinclair Puckett

ONE of the most curious results of the war was the almost complete disappearance of the monoplane. The writer saw only one solitary specimen during the latter half of the war, and that was a Fokker, a type that was used in the Near and Middle East at that time.

And yet, if one takes the four years immediately preceding the war, one finds that of 170 standard machines of all nationalities, no less than 108 were monoplanes.

Now that we are waging the fiercest peace on record, aeroplane design seems turning the other way, and the development of the monoplane as a commercial machine threatens to oust the biplane from its strong position.

There are several reasons for this, the chief one being economy. A monoplane is generally simpler to erect, rig, and repair; and is very often cheaper to build. But most important of all, it can be flown at a moderate cruising speed and with considerable load, with a comparatively low-powered engine. This means considerably decreased petrol consumption and less initial cost of engine. This will be very much the case when high-lift wings of the newest type are in general use. An example of this is the "wooden" Fokker monoplane recently seen in this country. This machine carries six people at 80 miles an hour with a 180 h.p. engine. A single-engined biplane of a well-known cross-Channel type carries eight people at 120 miles an hour with a 450 h.p. engine, and the latter engine consumes probably five times the amount of petrol and oil that the former does.

High-lift wings are, of course, those that give the highest lift-drift ratio, or, in other words, those that give the greatest proportion of lift with the least resistance or obstruction to the air through which they pass. Racing machines have wings of minimum lift and small resistance to the air, that is to say, wings of flat, narrow section and small angle of incidence. High-lift wings are being mainly developed along three lines, represented by the German type wing and the British Alula and Handley-Page wings.

The German wing, with which we are concerned here, has very great camber (curvature), very great thickness, and a very full, round leading edge. This wing is found to give a very considerably improved lift.

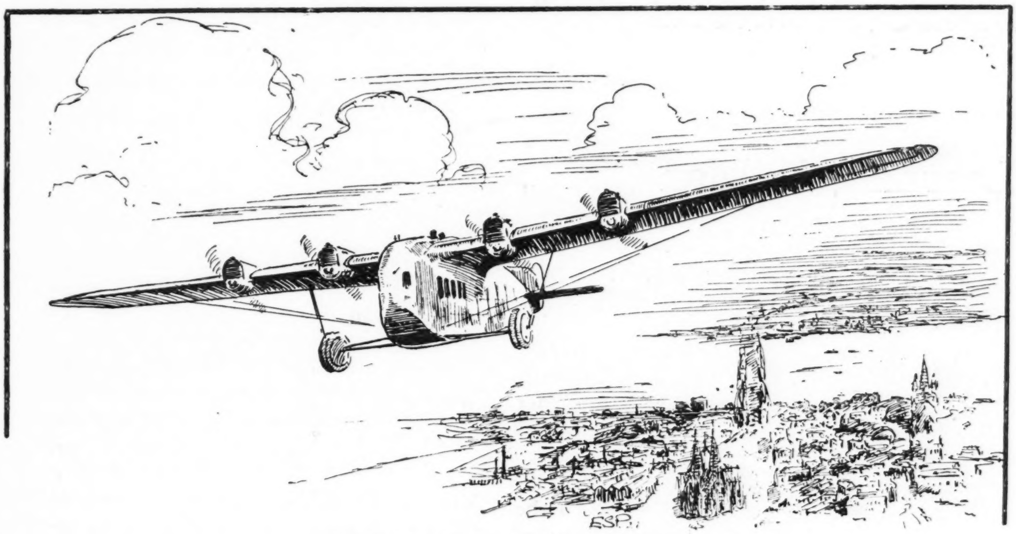
But the most important development in modern

aircraft is the construction of all-metal machines. This method of construction has been highly developed in Germany, where the celebrated Junkers' all-duralumin monoplanes have been much discussed for the past two years. The greatest achievement, however, in all-metal construction is the much talked of giant monoplane built in the Zeppelin works at Staaken.

This is the latest and largest example of an all-metal aeroplane, and is the biggest monoplane flying. It is constructed entirely of duralumin. The fuselage is devoid of longerons, or longitudinal spars, and consists of riveted sheet duralumin, kept rigid by a series of internal duralumin girder bulkheads. Indeed, the internal bracing of the fuselage is somewhat reminiscent of that of the Zeppelin airships. The fuselage is of very deep cross-section. The wings are of the German high-lift type, of very great thickness, and carry the four engines, two on each wing.

The engines are carried in nacelles, which are actually built into the leading edge of the wing, which is of such thickness as to permit the mechanics to crawl through a tunnel in the interior to reach the engines. Each engine nacelle has a seat for a mechanic, and is fitted with a nose honeycomb radiator. The engines are the 260 h.p. Maybach. These motors were the motive-power of the Zeppelin airships, and the sound of them is familiar to many people in this country.

The wings are, like the rest of the machine, covered with duralumin sheet, which is an integral part of the wing structure, adding vastly to its strength and rigidity, and is not, as in the ordinary wood and fabric wing, a mere covering. The wings are fitted with the usual type balanced ailerons.



ZEPPELIN GIANT MONOPLANE IN FLIGHT.

The under-carriage is of great strength and simplicity. It consists of horizontal V struts on either side carrying the wheel axle, thus avoiding a long axle, and a third telescopic strut, very deep from front to back, which runs from the wheel axle to the wing, midway between the engine nacelles. This strut is fitted with shock absorbers. Each axle carries twin side-by-side wheels of large size, about 4 feet in diameter.

The pilot's seat is on the top of the fuselage and gives a clear all-round view. The fuselage is furnished for the accommodation of eighteen passengers and a crew of four or five, and has a pantry, lavatory, and other luxuries. Although not particularly elegant, this great mass of glittering metal is a magnificent sight in flight, and bears throughout evidence of that excellence of design and construction associated with the Zeppelin works. The machine flies remarkably well, in spite of its heavy wing loading, and is easily dismantled for transport by railway or ship.

The main dimensions of this colossus are: Span, 104 feet; length, 59 feet 6 inches; height, 16 feet 8 inches; weight empty, 11,660 lb.; weight loaded, 20,196 lb. Total h.p. 1,040. The speed attained during the early trials was 111 miles an hour. Afterwards this was increased to 130 miles an hour. It will be seen, therefore, that it has a considerable turn of speed, and is probably the fastest large machine in the world. It will permit of being flown, however, at a very much more economical speed. Indeed, the above figures give some food for reflection. For one thing the wing loading (total weight divided by lifting surface in square feet) is extremely high, about 17 lb. to the

square foot, or over twice what is considered normal. Secondly the high speed. This probably is partly due to the good habit of German aircraft engines of working at something above their specified h.p., and partly to the careful streamlining of the machine and the sensible distribution and installation of the engines, which obviously offer very little obstruction to the air.

Another point is the remarkably low landing speed claimed by the constructors, which, with the very high wing loading and considerable speed of the machine, is stated to be no more than 55 miles an hour.

Altogether this is a very remarkable machine, probably the most original and most discussed of post-war aircraft, and from which there is much to be learned. Let us hope it is a portent of the future, a forerunner of the giant passenger-carrying aeroplanes that within a few years will be found flying regularly on the far-reaching air lines of the world.

Learning in Man and Animals

By Victoria Hazlitt, M.A.

Assistant Lecturer in Psychology at Bedford College, University of London

When animal learning is mentioned, the mind is apt to conjure up pictures of a dog sitting with a piece of biscuit on his nose, or of an elephant dancing, or of some other unusual and unnatural feat. It is perhaps for this reason that we are inclined to think of the animals' learning process as quite different from our own. In view of this tendency it may prove interesting to institute a comparison between the laws of learning in man and in an animal as low in the scale as a rat.

Some of the laws of human learning have been studied in experiments with meaningless syllables. These "nonsense" syllables are arranged in series and repeated as uniformly as possible until they are known. The learner endeavours to avoid making associations, as they would introduce an incalculable factor into the results. His work thus consists in forming verbal motor-habits which are one of the most characteristic of human activities. One of the rat's most characteristic activities is finding his way about in subterranean labyrinths. In order to study his process of learning under such conditions, a considerable number of experiments have been carried out in which the rat has had to learn his path through a maze. The rat is put at the entrance and is rewarded with food when he reaches the end. On the first occasion he usually spends a long time running into blind alleys and returning on his path. After a few repetitions, however, he avoids blind alleys and completes his journey in a minimum time. By means of these two methods—the one for human beings, and the other for rats—a number of problems connected with learning have been investigated.

It has been found that the number of repetitions for learning a long series is disproportionately great when compared with the number for learning a short series. For example, an experimenter who required, on an average, sixteen repetitions in order to learn a series of twelve syllables required thirty repetitions in order to learn a series of sixteen syllables, i.e. an increase of $33\frac{1}{3}$ per cent. in the number of syllables involved an increase of $87\frac{1}{2}$ per cent. in the number of repetitions necessary for learning. The following table shows that the same is true of rats:

Length of Maze.	Number of Repetitions for Learning.
9 feet	3·75
22 feet	9·73
27 feet	18·0
33 feet	27·0

These figures show that any increase in the length of the series to be learned by man or rat necessitates an increase approximately twice as great in the number of times that the series must be repeated. In the case of human beings, this is true only of learning which is not helped by the meaning of the material to be learned. Meaning and interest tend to reduce the effect of the length of the series.

Another fact which has been established experimentally is that the number of repetitions necessary for learning a given series by heart is affected by the distribution of the repetitions. For instance, a poem will be learnt with a smaller total number of repetitions if these are given once per day than if several are given at a time, and two repetitions on each of twelve days will ensure nearly five times as much being remembered as eight repetitions on each of three days. Experiments with rats show that the same law applies to their learning. When they run in a maze three times per day, the total number of repetitions which they require for learning it is almost twice as great as the total number required when they run in it only once per day. On the other hand, when the interval between the repetitions is greater than one day, the total number of repetitions increases for both man and rat. Human subjects remembered almost twice as much from eight daily repetitions as they did from eight repetitions given on alternate days. Rats who required six repetitions to learn a maze with daily repetition

required twelve to learn it when they ran in it with a two-day interval.

A third group of facts which has been established with regard to learning by heart concerns the most economical division of the material. If a group of people were asked to learn a poem by heart, practically all of them would repeat each verse over and over until it was known before going on to the next. Does the universality of this method rest on its superiority? Experimental evidence shows that it does not. The most economical method is to repeat the poem as a whole, or, if very long, to divide it into the largest sections that can be grasped as wholes. The size of these will vary with the experience and intelligence of the learner. If the material to be learned is very difficult and unfamiliar, it may be better to learn it in short sections. It appears also that sectional learning is better for motor activities such as complicated drill movements. Recent experiments have shown that rats learn a maze more quickly by learning it a part at a time, and that human beings resemble them in this when they learn maze paths under experimental conditions.

Another aspect of human learning is that the acquirement of one habit usually makes it easier to acquire another similar to it. Thus each piece of music is, on the whole, learned more easily than the last. The habits formed in one piece do not interfere with the habits necessary for another. In this, again, the rat resembles man. He learns each successive maze with greater ease, and attacks his later problems with the confidence and apparent enjoyment of his performance which characterise the work of a skilled musician.

Judging from the evidence at hand, there is an extraordinary resemblance between the laws of animal and human learning when the task concerned is the acquisition of motor habits. The inquiry into the subject of the differentiation of human from animal learning on levels higher than that of the acquisition of motor habit offers a fascinating field for research. While a great deal has been written upon the subject, there has been comparatively little exact experimental work.

Great Britain in the Latest Age. From Laisser Faire to State Control. By A. S. TURBERVILLE, M.A., and F. A. HOWE, B.Sc. (John Murray, 7*s.* 6*d.*)

Measure Your Mind. By FRANK P. STOCKBRIDGE and M. R. TRABUE. (Harrap & Co., 10*s.* 6*d.* net.)

A book on Mental Tests by two Americans. See review, p. 106.

The Islanders of the Pacific, or The Children of the Sun. By Lieut.-Col. T. R. ST. JOHNSTON, late District Commissioner of the Lau Islands, Fiji. (T. Fisher Unwin, 25*s.*)

An Up-to-date Meteorological Equipment—II

By Donald W. Horner, F.R.A.S., F.R.Met.Soc.

SELF-RECORDING RAIN-GAUGES

IT is a curious fact that the first rain-gauge to be constructed was not an ordinary instrument but a self-recording one, the principle of which was suggested by Dr. (afterwards Sir Christopher) Wren, who is better known popularly by his architectural work than by his scientific experiments. On January 22, 1662, he demonstrated this particular experiment before the Royal Society by filling a vessel with water, which emptied itself when filled to a certain height. Ten years later a self-recording rain-gauge on this plan was constructed to the order of the Royal Society.[1]

In the first ordinary rain-gauge that was constructed the water was not measured but weighed. This *pluviometer* was invented by Mr. Robert Hooke in 1695.

This rain-gauge was of a very primitive design, merely consisting of a large glass bottle holding more than two gallons and having a neck 20 inches long. The funnel too was made of glass, and was 11·4 inches in diameter, the whole being fixed in a wooden stand, something like an old-fashioned jelly-stand. The funnel was steadied by two pack-threads attached to the frame by pins and passing over the edge of the funnel. The amount of water collected was carefully weighed every Monday morning, and it was found that between August 12, 1695, and the same date in 1696, using troy weight, the rainfall in the interval weighed 131 lb. 7 oz. 113 grs., equivalent to 29·11 inches.

This digression into the history of the rain-gauge has been made to show what a very considerable advance has been brought about since the early days of rainfall recording. Primitive simplicity has given way to the complicated mechanism of the up-to-date instruments about to be described.

In *British Rainfall* for 1905 Dr. H. R. Mill, the Director at that time of the British Rainfall Organisation, said: "Rainfall duration has not yet been much investigated, and it would be of real importance to obtain additional records on which to base an opinion as to the geographical distribution of rainfall duration."

To meet this requirement Messrs. Negretti and

[1] "Contribution to the History of Rain-gauges," by G. J. Symons, F.R.S., *Quarterly Journal*, R. Met. Soc., vol. xvii, No. 79.

Zambra brought out a recording rain-gauge called the *Hyetograph*, constructed under Halliwell's patent. This design was approved by Dr. Mill, and since then

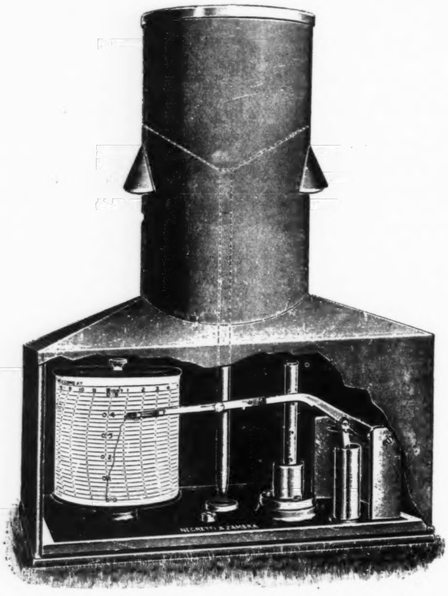


FIG. 5.—THE "1908" HYETOGRAPH (*Original Pattern*).

(1908) an improved form has been introduced, known as the "1919 Hyetograph."

In Fig. 5[1] we see the original pattern instrument, and in Fig. 6 a sectional diagram of the 1919 improved apparatus.

It should be mentioned that in Halliwell's Patent Rain-gauge the water in the float cylinder is made to siphon away.

To obtain an absolutely trustworthy automatic siphon would be a great deal too expensive for use in a gauge at a relatively low price, and to obviate this difficulty the Hyetograph was constructed with a mechanical device which affects the pen only, and gives an open scale of $\frac{1}{2}$ inch of rainfall recorded on a chart 3 inches high.

When the Hyetograph is in action, so long as rain is falling the float D (Fig. 7) continues to rise, up to a maximum capacity of $4\frac{1}{4}$ inches. On a spindle E, rising from the float D, are a number of projecting pins FF which engage successively with a projection on the lever G, this lever being so pivoted that when the pen reaches the top of the chart the lever disengages with the pin and falls by its own weight on to the next lower pin, which is so placed to allow the pin to fall to zero on the chart. The float therefore continually ascends during rainfall, but at each successive half-inch of rain the pen descends to zero and recommences its upward movement.

As no automatic siphon is used, it is obvious that the rain will collect in the float-chamber until it is removed, and the float cylinder is made sufficiently large to allow an accumulation of over 4 inches of rainfall, the maximum usually likely to occur in one day in any locality in Great Britain and Ireland, except the wettest parts of the Lake District and on high mountains.

In order to remove the water the Hyetograph is constructed with a specially designed hand-started siphon which is actuated when desired; this empties the float-chamber of any water which may have accumulated therein.

The chart is wound round a cylinder which makes one revolution in 24 hours; the effective length is 10·8 inches, giving 0·45 inch for an hour.

From this brief description of the instrument it will be noticed that its advantage over other apparatus of its kind is its simplicity; it has very few parts to get out of order and it is very easy to set up. A good plan is to erect it over a 6-inch drain-pipe, the large end of the pipe being uppermost, so that the flange is level with the ground; then when the water is siphoned out of the Hyetograph it flows directly into the pipe and so into the ground.

The general principle of the 1919 Hyetograph is similar to that already described, but has embodied in it some important improvements. In the older instrument the trace on the chart was a curve; in the new one it is a *straight line*, and anyone who has had experience in tabulating traces will at once appreciate the advantage of this arrangement.

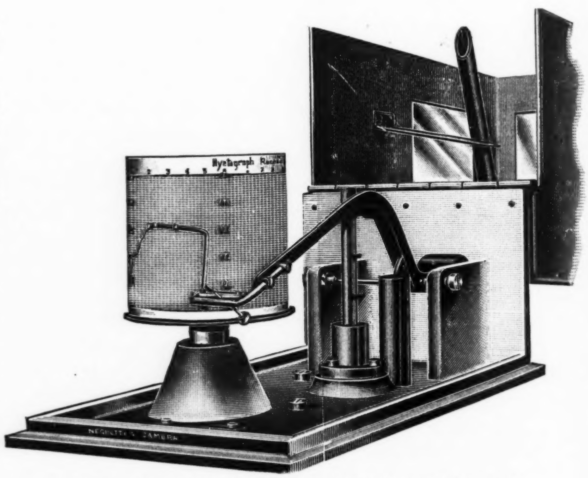


FIG. 6.—THE "1919" HYETOGRAPH (*Sectional Diagram*).

[1] Illustrations reproduced by permission of Messrs. Negretti and Zambra, London.

Also in the new instrument the pen-arm is counterpoised to obviate the effect of friction. Possible friction between pen and chart is also eliminated by

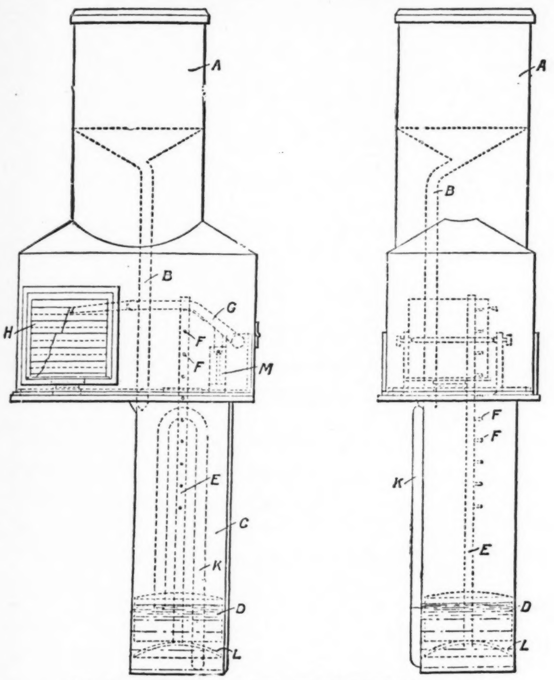


FIG. 7.—SECTIONAL VIEW OF THE HYETOGRAPH.

the use of the swinging pen-arm. The pen rests lightly by its own weight on the chart. This ensures great clearness of writing.

A more expensive form of Self-Recording Rain-gauge is that known as the "Fernley" (Fig. 8), designed at the request and under the supervision of Mr. Joseph Baxendell, the Director of the Fernley Observatory, Southport. This gauge may be classed with the Hyetograph as a first-class Recording Rain-gauge.

In this form of self-recording gauge the rain-water passes from the funnel into the float-chamber and causes the float to rise as far as the top of the chart, this representing ½ inch of rainfall. At this point the water siphons away, the float falling to zero in six seconds, ready to commence a fresh trace. The siphon is actuated by means of a tilting bucket. As soon as the float and pen reach their highest point, the bucket overturns and the water pours through a pipe. In this way the reservoir is quickly emptied.

Having now outlined the principles and mechanism of the two most important forms of self-recording pluviometers, we will proceed to show how they can be utilised in the pursuit of our knowledge of the cause and effect of precipitation.

On May 15, 1907, Dr. Hugh Robert Mill, then President of the Royal Meteorological Society, read a paper on "The Best Form of Rain-gauge."[1] In this paper he stated that the three best forms of ordinary rain-gauge are the "Snowdon," the "Bradford," and the "Meteorological Office" patterns, and later (in 1908) he gave his unqualified approval of the "Hyetograph." It will be seen from this that we have now treated of all the most important forms of pluviometer, and it only remains to show the relation existing between observations made with ordinary rain-gauges and self-recording instruments.

When we measure the rainfall at 9 a.m. in a simple rain-gauge and write down the result against the *previous day*, as is the usual custom, we know only that a certain amount of rain-water has been caught in the gauge during the past twenty-four hours, but we have no means of discovering the intensity of the fall at any particular time during the period.

The self-recording gauge can give us this information. During the whole of the twenty-four hours a continual record is being taken on a revolving clockwork drum, and when we visit the instrument and look at the chart it tells us at once the rate at which rain was falling at any particular time.

With a gauge such as the Hyetograph it is possible to secure the maximum rate of rainfall during thunderstorms and other heavy downfalls, in a way which would be entirely impossible with an ordinary gauge, and we can also obtain the mean hourly fall for the month or year.

For some years past in *British Rainfall* a section has been devoted to heavy falls in short periods, and the discussion of these values would have been impossible without the results obtained by the improved form of self-recording rain-gauge.

FIG. 8.—FERNLEY SELF-RECORDING RAIN-GAUGE.

In the previous article it was mentioned that a "rain day" consisted of one on which 0·01 inch or

[1] *Quarterly Journal* of the R. Met. Soc., vol. xxxiii, No. 144, p. 265.

more of rain had fallen. It is pointed out, however, in *British Rainfall* for 1919, just published, that this value is gradually becoming obsolete, and for the following reasons: The recognised "rain day" for observers measuring in millimetres is a day on which 0·2 mm. or more is recorded. If the inch be the unit employed, a fall of 0·01 inch or more constitutes a "rain day." In a 5-inch rain-gauge these amounts are represented by 3·2 c.c. and 2·5 c.c. of water respectively, and this discrepancy in these units of measurement is added to the already existing sources of uncertainty given in the previous article.

The obvious remedy for this state of affairs is to increase the value to a larger quantity, provided, of course, that the amount is not *unduly* large. The smallest value on the respective rainfall scales at which the inch and millimetre virtually coincide is, as we have previously stated, 1 millimetre, which equals 0·04 inch almost exactly. Now, 1 mm. of rain in a 5-inch gauge means 12·7 c.c. of water, and 0·04 inch means 12·9 c.c. This amount is sufficiently large to eliminate the small errors occasioned by the difficulty of accurate measurement, and small enough to include all days of significant rainfall.

It is not, however, at present proposed to do away with the present definition of a rain day, but to supplement it by another term, a "wet day," which shall be considered as a day ending at 9 a.m. on which 1 mm., or 0·04 inch, or more of rain is recorded.

Moreover, it has been decided that a "dry spell" shall be a period of fifteen, or more, consecutive days no one of which is a "wet day" according to the foregoing definition; and a "wet spell" shall be a like period each one of which is a "wet day."

Till recently it has been the practice to take a period of more than fourteen consecutive days every one of which is a "rain day," that is, a day on which 0·01 inch or more fell, and to call it a "rain spell"; and to take a similar duration of time without measurable rainfall and term it an "absolute drought." It has been found, however, from figures published in *British Rainfall* during seventeen years, that the "rain spells" greatly outnumber the "absolute droughts." It is hoped that the new definitions will tend to eliminate this undesirable disparity.

Improvements are still being made in these instruments. Messrs. Negretti and Zambra will shortly introduce a Recording Rain-gauge with a natural siphon action, and also an instrument for recording the actual rate of fall of rain at any given moment. The Meteorological Office has one of each of these instruments under test at the present time, and the results of its investigations will be awaited with interest by meteorologists.

In conclusion, it must be remarked, before leaving the subject of rain-gauges, that whatever kind we employ they must be set up *perfectly level.* Especially is this the case with self-recording instruments, whose level it is necessary from time to time to test with a spirit-level. If, however, the instrument is set up originally in a cement-concrete bed, and levelled up accurately, further trouble in this respect is unlikely.

The Elder Edda[1]

THE Great Cold that they had dreaded has fallen upon the Scandinavian gods: the winter that knows no spring. The Grey Wolf has devoured Woden and stands on the high places of Asgerd, a deadlier than the breed of Fenri that the Sibyl prophesied, the Grey Wolf of forgetfulness. For there has been a twofold Doom of the Gods. There was the coming of that Other whom the Sibyl dared not name, and for the sacred ash Igdrasil the uplifting of the Holy Rood. And again, long after, when the wheel had come full circle and the pagan years returned, it was to find

> "Many a fallen old Divinity
> Wandering in vain about bewildered shores."

It was not the Giants that held their inheritance, but the Olympians. Olympus had conquered Asgerd, for "first in beauty should be first in might," and few have eyes for Freya riding on her Boar, however golden his bristles, when they have

> "Hailed thee re-risen, O Thalassian,
> Foam-white from the foam."

Thor and Woden, Loki and Frigg, one looks for them in vain among the "damnèd crew" in Milton's *Ode on the Morning of Christ's Nativity*. Moloch and moonèd Ashtaroth are there, but these have escaped the bale of hell, because their very memory was forgotten.

It was, curiously, in the eighteenth century, the century of the spiritual east wind, that the frost began to yield, and Gray, with his shy scholar's passion for wild earth, discovered again its gods. For gods of wild earth they are. The Greek gods have captured the world of the imagination, and the "diverse far-off image of delight" clothes itself in their radiant names; but they are fair-weather gods at best. Always behind Apollo and Aphrodite one sees sun-stained marble and a sickle-sweep of warm sand and the blue Greek sea. But in the northern islands it is Thor who

[1] *The Elder Edda and Ancient Scandinavian Drama.* By Bertha S. Philpotts, O.B.E., Litt.D. (Cambridge University Press. 21*s.* net.) [The *Elder Edda* is the very oldest collection of Scandinavian Myths.]

shouts across to the ferryman when the river comes down in spate, and Loki's face that leers from the green gnarled bark of the trees in the woods; Weyland's smithy stands by the brawling ford, and Woden, the maker of secret spells, is the hooded figure abroad in the darkening fields. These are the gods of the Elder Edda, not yet ascended into Valhalla, not yet detached from the stone and the tree-trunk that was their earliest shrine.

This is why Miss Philpott's study of the Elder Edda is for all men, and not for scholars only. "My aim," she writes, "is simply to place before scholars a theory of the dramatic origin of the Elder Eddic poems." But in unravelling the ritual of which drama was born, the old world has staged itself, and the flame again wakens about the barrows of the dead. Even the beast disguises that so revolted St. Egbert and St. Theodore, for which one did three years' penance, are seen no longer bestial, but guises of the friendly creatures who wept for Balder, and once shared our life as they do to this day, until one grows tall enough to stoop to pat a dog. The only drawback is that so fine a gift of translation has been used so sparingly. Miss Philpotts had intended, she writes, to give a translation of the more important poems in an appendix, and did not, lest she should forestall another and a better hand. But there is no *mare clausum* in translation. Some of us, knowing the druid world that masks itself behind the formal scholar's title of the *Corpus Poeticum Boreale,* would have held that felicity of translation could no farther go. "Now I swear that there shall never be a greater marvel than this, early or late at Sevafell. . . . It is time for me to ride the reddening roads, to let my fallow steed tread the paths of air. I must be west of Windhelm's bridge before Salgofni awakens the mighty host." Yet hear this—"Now I swear that men at Sevafell shall marvel at naught hereafter, neither soon nor late. . . . But it is time for me to ride the reddening ways, to urge my pale steed on the paths of the air. I must be west of the bridge of Windhelm before the cock on Valhöll awakes the warrior host."

As to the development of the actual thesis, it marches like the sea. One's pleasure in reading it—it had better be read at a sitting—is the satisfaction of a demonstration in mathematics. Every chapter is "the stroke of a strong swimmer." One is the more malcontent that the last two chapters have somewhat suffered from the toll that the last five years have taken from scholarship. The analogy between Greek drama and this other, arrested at the moment when tragedy was about to break the ritual mould, might have made another book. For the last, on the bearing of the theory on the ballad, the epic, the folk and the Church play, it is a chapter of valuable suggestion; but when it ceases to be suggestive and becomes dogmatic, consent is less secure. "The religious origin of the heathen drama will hardly be questioned. But the heathen origin of the ecclesiastical drama practically follows from that premise." Now, it is to be remembered that ecclesiastical drama rose first, not in places where the heathen tradition was strongest, but in the great Benedictine strongholds such as Fleury and St. Martial of Limoges and St. Gall, side by side with the enriching of liturgical music, the art of stained glass and of engraving in gold, all of them tributaries of the great liturgical development that centred in Cluny, the magnifying of the *opus Dei* which was the ideal task of the Benedictine Order. "Religious drama in England was known in the Anglo-Saxon period," but it was founded on the customs of Fleury and Ghent, and it is the vexation of scholarship that it seems to have taken so little root till after the Conquest. Moreover, the liturgical play was not "discouraged by the ecclesiastical authorities," except by some of the austerer sort, the eternal Puritan voicing himself in Gerhoh, or our own Grossetëte of Lincoln; and the famous decretal of Innocent III against *ludi theatrales* was almost certainly directed not against the "representationes" of the mystery of the faith, but the abuses of the Feast of Fools. Nevertheless, the very over-emphasis with which the theory is stated may help the balance to right itself. It has been the tendency of recent scholarship to stress too much the provenance of the dramatic seed, and ignore the "shaping spirit of imagination" inherent in the soil where that seed was flung. The Elder Edda has proved the richness of it, not only in promise but in achievement. When the author of the *Lay of Helgi Hundingsbane* saw Sigrun face to face with her lover, and between them the bodies of the father and brother that he slew——

Helgi said: "Take comfort, Sigrun! A Hild hast thou been to me.
Kings cannot withstand Fate."
Sigrun said: "Fain would I that some should live who now are dead,
And yet would I clasp thee in my arms"—

he saw tragedy, the thing itself, as the Greeks saw it. It is small wonder that Miss Philpotts speaks a little wistfully of "that tragic drama which suffered no untimely death, but was allowed to develop to its full stature." The tragedy of the Elder Edda is broken, but it is the broken figure of a god.

HELEN WADDELL.

The "Oresteia" of Æschylus. Agamemnon, Chœphori, Eumenides. The Greek Text with an English Verse Translation by R. C. TREVELYAN. (Bowes & Bowes, 5*s.*)

Tropical Agriculture[1]

By C. A. Barber, Sc.D., C.I.E., F.L.S.

THIS book, we note from the preface by Mr. J. MacKenna, is based on a series of lectures delivered by the author to his class of students in the Cawnpore Agricultural College while he was Principal. As it deals with the whole fabric of agricultural economics in the United Provinces, its appearance at the present time would appear to be singularly opportune, for the daily papers are filled with accounts of widespread disaffection among the peasantry of this part of India, where the agitator has been specially busy of late. The lectures are apparently intended for the land-owning classes, who have recently suffered considerable losses from rioting and wholesale looting; they were not apparently intended for the education of the cultivator himself, and this should be borne in mind in reading the book, as it assumes a considerable education and knowledge of local conditions. The book will thus present difficulties for those not in some way prepared for the vast differences between agriculture in a temperate climate and that in the warmer parts of the globe, and for the special conditions prevailing in the North of India. We should, therefore, warn the student of tropical agriculture that, for full advantage to be obtained from its perusal, much preparatory work will be necessary. It is a book rather for the advanced English student than for those who are only commencing this complicated study.

The author commences with a section on the origin of the primitive community, tracing it in the first instance to the increase in population and a corresponding difficulty in obtaining food; from this, by easy stages, we are led to the formation of the village, and, later on, to the great city, drawing its supplies from distant parts of the country with the development of railways, and even from different countries as shipping increases. It is a fortunate circumstance that, in this study of evolution, examples can readily be drawn from India itself, where we have all stages from the wandering savage to the civilised inhabitant of the large town. After thus laying his foundation, the author develops his study in two directions concurrently, namely, those of agriculture and economics; and in each of these a separate section is devoted to the basis on which the science is founded and on its development.

Such a work is exceedingly welcome at the present day. The student of tropical agriculture is at present very badly off for books, and much of his time and that of his teachers is inevitably dissipated in hunting up papers in the agricultural journals of different countries—a laborious and thankless task. It is true that a number of treatises of great value have appeared from time to time on single crops, such as cotton, sugar, rubber, tea, coffee, cacao, and there are also several books on what may be called "planters' products"; but we are singularly deficient in works of a general character. The book on tropical agriculture has still to be written. And the reason for this is not far to seek. Works of this nature, the description of the vegetable products of a country and the methods of cultivation and their extraction, need the personal touch. This will not be present in anyone who has not himself taken part in the work, and the domain is so vast and varied that few sojourners in the tropics can have studied adequately more than one or two different regions. The compilation of a satisfactory agricultural textbook of our own small country would cover a number of volumes: what can we do with a hundred countries, scattered over the tropical belt, differing in almost every conceivable respect—physical configuration and climate, races varying from complete savagery to ancient civilisation, widely diverse crops and still more widely differing methods of cultivation? Any attempt to bridge this gap in our library is to be encouraged, and Mr. Martin Leake's book, which deals with fundamentals rather than details, and with a wider aspect of agricultural economics, should be read by every thoughtful student of the subject.

To give some idea of the variations met with in tropical agriculture, judged by methods of cultivation alone, it is first of all necessary to formulate some method of classification. Among many possible ones, we have divided the subject into three rough groups, radically differing from one another—namely, the collection of the produce of wild plants; the settled, ancient cultivation of civilised communities, self-contained and devoted to their own requirements; and the cultivation introduced by European settlers intent only on the export of their produce to the centres of population in the temperate regions from which they have migrated. These three differ very widely in every respect, although they insensibly pass into one another in most countries.

The mere collection of the produce of wild plants is characteristic of a primitive stage of development, and yet we still receive some of our most valued raw materials in this manner. Such, for instance, are the oil from palms on the west coast of Africa; rubber, until recently obtained from the forests of the Amazon and the forest regions of Africa; gums and spices from the entire fringe surrounding the great deserts of North Africa. Sugar and spirit are obtained from the most varied palms; starchy foods from palms, cycads, roots;

[1] *The Bases of Agricultural Practice and Economics in the United Provinces, India.* By H. Martin Leake, M.A., Sc.D., F.L.S. (Heffer and Sons, Ltd., 1921, 15s.)

cola from the West African forests; shea butter from the hinterland of Nigeria and the Gold Coast, and so forth. And to these may be added many other plants only recently brought together in orderly plantations: pepper, cacao, cocaine, coffee, quinine. There is, in fact, a constant striving, even in these latter days of progress, to emulate the work of the primitive savage, who brought a few seeds and planted them near his chosen place of abode.

The range of ancient agriculture in the tropics, which is the heart of the study, may best be learnt by constructing a map of the world, showing the employments of mankind in the fifteenth century, the age when we began to appreciate how big the world was. The turning-point coincides with the finding of the Cape route to the Indies and our discovery that a great western continent existed. In the New World thus discovered, little of settled agriculture existed beyond the domain, on the western coasts, of the Aztecs and Incas, whose cultivation is unfortunately lost, but to whom we are indebted for the best varieties of cotton, tobacco, pineapples, maize, and other crops. The rest of the Americas, largely covered by dense forests, was ranged by warlike peoples who devoted themselves to hunting and fishing. In Africa, the great central plateau was covered from north to south by wandering tribes, often at war with each other, and little settled agriculture can be traced but in a few isolated tracts, always excepting the extreme north, cut off by impassable deserts, the Mediterranean coast from Egypt to Morocco. In Oceania, with its exuberant vegetation, little more was needed by the inhabitants than to put out their hands and gather the fruits of the earth. But in Asia, with its teeming populations, a very different state of things existed. We know that, from remote times, thousands of years before the Christian era, agriculture was a valued art, and, to emphasise this, the five sacred crops, rice, wheat, barley, millet, and beans, were annually planted with much ceremony by the Emperor and his courtiers. In India, cotton and sugar-cane were cultivated also in remote antiquity, although the earliest existing references are only 800 years B.C. And doubtless similar circumstances prevailed throughout the south-eastern portion of the continent and the adjacent larger islands. The study of the vast accumulated agricultural lore in these tracts is a life's work, and forms the basis of tropical agriculture of to-day.

On an entirely different plane is our third division, the agriculture responsible for our coffee, tea, cacao, rubber, and to a less extent sugar, cotton, and spices, broadly included under the title of "planters' products." Most of these owe their increase to the invasion of tropical countries by inhabitants of temperate regions, bringing with them their energy and capital, and capable of effects quite impossible to the local races. Although cotton, sugar-cane, cacao, and rubber are produced at low elevations, the settlers naturally congregated together, chiefly in the more elevated tracts, where the population was scanty and the climate cool and suited to their needs. And this scantiness of population made it necessary to introduce labour from the excess in the plains. Cultivation in these regions is of an entirely different nature from that in the plains, and its principles have been largely built up on the unfortunate experience of pioneers: the planters are now laboriously remedying the errors of the past, and fighting the hordes of pests and diseases introduced by inefficient agricultural methods. Almost all of the plants in this tract are perennials, often shrubs or even trees, which fact, together with the irregular contour of the land, rules out the plough, and cultivation, therefore, depends on hand labour. The planters have, accordingly, introduced the spade and fork, unknown in the plains.

Naturally, no general rules can be laid down for the treatment of soil in such different conditions, and the conditions in the separate staples in each class differ quite as widely among themselves. The methods of cultivation of rice, which is a water plant, and the millets, which will thrive on the minimum of rainfall, differ as the poles; so do the intensive field work in the cane-fields and the extensive among the various fibre plants. The only way is to take the crops and countries one by one, recognising the fact that the study of tropical agriculture is limitless. A whole life may be spent in the study of cotton or sugar or rubber with gaps still left in one's knowledge. But the study, if disheartening, is full of interest, and well worthy of a place in the curricula of our schools, where it is gradually forcing its way to recognition.

An Introduction to String Figures. An Amusement for Everybody. By W. W. ROUSE BALL. (Heffer, 2s.)

Mr. Rouse Ball's book will be a joy to all who are interested in making figures out of a piece of string with the hands. He has collected all the best figures, describes very clearly how they are made, and gives diagrams to show the completed work. This is an amusement for everybody and, like games of patience or jig-saw puzzles, will be especially suitable for whiling away many a dull hour for an invalid in bed. Everyone who possesses a piece of string and is interested in doing stunts with string should get this book and learn to make the figures.

The Backward Peoples and our Relations with Them. By SIR HARRY JOHNSTON. (Oxford University Press, 2s. 6d.)

Reviews of Books

The Measurement of Intelligence. By PROF. LEWIS M. TERMAN. (Harrap & Co., 8*s.* 6*d.*)

The Intelligence of School Children. By PROF. LEWIS M. TERMAN. (Harrap & Co., 8*s.* 6*d.*)

Measure Your Mind. By F. P. STOCKBRIDGE and DR. M. R. TRABUE. (Harrap & Co., 10*s.* 6*d.*)

These three books are not only what our elders and betters call highly instructive, but they are also exceedingly good fun. If they are read and studied in the order I have placed them, they should serve, I think, to introduce readers to a very fascinating subject—that of mental tests. The titles sound dry enough. Intelligence, school-children, measuring the mind, these call to our minds the pedagogue. But remember we are not in school. And these books, as pedagogues out of school may be, are interesting, entertaining, and at times highly amusing.

It was a gentleman of the name of Binet, a Frenchman, who was the first to put this business of mental testing on a scientific basis. He succeeded, as Professor Terman has said of him, in bringing down a good deal of psychology from the clouds and making it useful to men. But fifty years ago Francis Dalton had predicted that sometime it might be possible to obtain a general knowledge of the intellectual capacity of a man by sinking shafts, so to speak, at certain points. This is what mental tests do. Galton's prediction is now in process of being realised.

Binet spent fifteen years in working out his system of mental tests. It was published in 1908, and is known as the Binet-Simon Intelligence Scale. This scale consisted of fifty-four tests ranging in difficulty from tests that may be passed by the average child of three years to tests which would be considered difficult enough by the average grown-up. This work of Binet's was great pioneer work. His scale has since been considerably modified by Professor Terman and his pupils at Leland Stanford Junior University in California. They have increased the number of tests to ninety, and have extended the scale sufficiently to measure the intelligence of "superior adults." These tests are called the Stanford Revision. They give, I think, a better diagnosis of our mental capacity than the original Binet-Simon scale. They include tests of memory, comprehension of language, size of vocabulary, orientation in time and space, co-ordination between hand and eye, knowledge about familiar things, judgment, ability to find likenesses and differences between common objects, arithmetical reasoning, resourcefulness and ingenuity in difficult practical situations, ability to detect absurdities, apperception, the speed and richness of association of ideas, the capacity to generalise from particulars, the ability to deduce a rule from connected facts and so forth.

Here is one of the Stanford problems :

A mother sent her boy to the river and told him to bring back exactly seven pints of water. She gave him a three-pint vessel and a five-pint vessel. Show me how the boy can measure out exactly seven pints of water, using nothing but these two vessels and not guessing at the amount. You should begin by filling the five-pint vessel first. Remember, you have a three-pint vessel and a five-pint vessel, and you must bring back exactly seven pints.

This problem is given orally, but may be repeated if necessary. The person questioned is not allowed pencil and paper. The time allowed is five minutes.

Below is another problem :

Repeat Backwards 4-1-6-2-5-9-3 ; 3-8-2-6-4-7-3 ; and 9-4-5-2-8-3-7.

A test which should be passed by the "average adult" consists in repeating twenty-eight syllables. The sentences for this test are :

(*a*) *Walter likes very much to go on visits to his grandmother, because she always tells him many funny stories.*

(*b*) *Yesterday I saw a pretty little dog in the street. It had curly brown hair, short legs, and a long tail.*

The sentence must be repeated without a single change of any sort. The test is passed if one sentence is repeated correctly.

These, however, are merely samples, and away from the context and the rules and regulations governing them they lose much of their importance. The whole thing (the Stanford Revision) is explained lucidly and at length in *The Measurement of Intelligence*. The necessary technical terms are carefully explained, the reliability of the methods employed is discussed, and the instructions for giving the tests to children are set forth in detail.

A reader looking through the tests might wonder if psychologists or teachers are justified in attributing the significance they do to tests many of which are familiar as parlour games or as puzzles in the children's page of the popular weekly. Here, as in every scientific investigation, we must be guided by what the experts say. Their opinion is that the significance of mental tests lies in the fact that each test and the scale as a whole have been carefully standardised on the basis of age. The series of tests has been tried upon many hundreds of normal children. A boy who can pass a test which experience has shown can be passed by the *average* child of eight years is said to have a "mental age" of eight. If he can pass not only the eight-year-old test but also those set for children of nine and ten years, he is said to have a mental age of ten years. If he passes the six-year-old test but fails at the seven-year test, however, he has a mental age of six.

The importance of mental age for the teacher lies, then, in the fact that it may be used as a basis for grading the pupils. Should a boy of eleven with a mental age of fourteen leave the class he is in and be put in the higher class in which the average age is

fourteen? Professor Terman says yes, emphatically. He declares that skipping classes in these circumstances is justified, and quotes his experience and authorities for his statements.

In addition to an index of absolute mental level, the mental age, an index of relative ability is necessary in this study. This is called the "intelligence quotient" (IQ). It is obtained by multiplying by 100 the ratio of mental age to chronological age. For example, a clever boy of seven with a mental age of ten would have an IQ of 143; an average boy of ten one of 100; and a feeble-minded boy of sixteen with a mental age of ten one of 62. In each of these three cases the mental age is the same, but the intelligence quotient indicates whether a child is clever, average, or dull. It is a measure of ability.

Professor Terman's second book (published in February of this year), *The Intelligence of School Children*, deals with the use of mental tests in school-grading, and the proper education of exceptional children. It illustrates the large individual differences in original endowment which exist among school-children, and shows the practical bearing of these differences upon the everyday problems of class-room management and of school administration. He discusses fully what may be expected from, and what ought to be done for, pupils of different degrees of intellectual capacity.

The most interesting part of the book to the general reader is the able study of forty-one "superior" children. Very clever children are commonly supposed to turn out very dull in after-life, and many men and women who show marked ability are commonly supposed to have been "very ordinary" at school. Professor Terman's experience—and it is a wide one—is that both of these common suppositions are wrong. An intelligent boy becomes an intelligent man, a very intelligent boy a very intelligent man, and so on. Feeble-minded or dull children never blossom out into keen, alert, and intelligent men and women. This rule seems to hold generally, and the exceptional cases which have led to the common suppositions mentioned may be easily and reasonably explained.

Professor Terman's top-notcher is a boy D. B. When he was tested he was just under 7 years 5 months. His mental age came out as 13 years 7 months. His IQ consequently was 184 (100 is the normal). This is the highest intelligence quotient in Professor Terman's experience.

D. B. is an American boy. His father is Russian-Jewish, his mother Polish-Jewish. On both sides he is descended from men and women of unusual ability. At six months he stood alone, and at nine months he walked. He played at anagrams when a baby, and learned to read as gradually and naturally as he learned to talk. At three, without his parents knowing he could do it, he picked up a new book suitable for children of nine years and read it through intelligently. He handles "Meccano" models requiring deft fingers, type-writes rapidly, using two fingers only on each hand, and has taught himself printing. He reads for eight or ten hours a week, and always rapidly. He has already read the *Iliad* and much of Shakespeare, and has a particular liking for the historical plays. *Pericles* is his favourite. He has read every history book in his home, and these include Gibbon and Crote. He criticised Gibbon as "having left too much out" in writing about Rome. Among his papers are sundry notes marked "Important things the Scottish kings did," "List of Roman emperors and what they ruled over," etc. History is his favourite subject.

At seven years of age he commenced issuing a weekly playground newspaper, a one-sheet, three-column affair, typed. He writes the whole of it himself, and does the typing too. There is a joke section, an advertising section, a news section, and various extras and incidentals from time to time. The jokes are often such as would not be understood by children below the mental level of twelve years.

This prodigy has other qualities. He is conscientious and truthful. He obeys instructions regarding errands. He is considered above the average in unselfishness. He loves to share his things with others, and remarks at selfishness in others.

Whether he will fulfil this present promise, only the future can decide. But there is every indication that he will become a very great man.

Measure Your Mind, the third book on the list, differs from the two others in that it deals with mental tests, for adults only. There are thirty different sets of tests, each of which has from six to twenty-four questions. Full instructions regarding the conditions under which the tests are to be given and the manner in which marks are to be scored are given with each.

From the marks of each test the person tested is graded as possessing Very Inferior Ability, Inferior Ability, Average Ability, Superior Ability, or Very Superior Ability.

The tests differ very widely, but all are designed as far as possible to test general intelligence, and not merely acquired knowledge or special ability in one or two particular directions. The first deals with the detection of Pictorial Absurdities, and brings back to mind the evenings when we used to do competitions in the boys' magazines—a drawing of an aeroplane with the pilot facing the wrong way, a boy with six fingers on one hand playing with a bat, and so on. Next we have a competition in threading our way through mazes. If we get through them all in a given time we are of "very superior ability." If we do ten only out of twenty, we are of "low average ability." Several geometrical and drawing problems follow, all very interesting, all very amusing. There are addition tests, tests of memory for numbers and of memory for sentences. Next come tests which deal with range of information, spelling tests, and handwriting tests. Disarranged sentences have to be arranged properly and letters to be composed. There is finally a test in what is called poetic discrimination. It is essentially a test for editors. In this test several verses from good poems have been rewritten more or less badly twice,

and the problem is to rearrange each set in descending order of merit.

Which is the poorest poetry, and which the best, of these ?—

Music, when faint voices cease,
Continues in the memory—
Odours, when the violets fade,
Linger where their smell was made.

Music lives in the memory,
Though the songster's voice is done.
Sweet odours haunt the nose,
Though the violets that waked them are gone.

Music, when soft voices die,
Vibrates in the memory—
Odours, when sweet violets sicken,
Live within the sense they quicken.

Altogether an interesting book; very American, with a great deal of sound sense and helpful advice in its pages.

P. K. F.

New Studies of a Great Inheritance. Being lectures on the Modern Worth of some Ancient Writers. By R. S. CONWAY, Litt.D., F.B.A. (John Murray, 7*s.* 6*d.*)

The lectures deal with the inner experience of Cicero, Horace as poet laureate, the youth of Vergil, the fall of Cornelius Gallus (published originally in the first number of DISCOVERY), the place of Dido in the history of Europe, and other subjects. The treatment is simple, interesting, scholarly. The lectures are designed to represent some of the elements in the work of the ancient writers, especially those of Rome, which make their study of permanent value; and, in particular, to indicate as clearly as possible how much in the ethical framework of modern society may be traced directly to their teaching.

Books Received

The Elements of Descriptive Astronomy. By E. O. TANCOCK, B.A. (Clarendon Press, 3*s.* net.)

Laboratory Projects in Physics. By FREDERICK F. GOOD, A.M. A Manual of Practical Experiments for Beginners. (Macmillan & Co., 9*s.*)

Mechanism, Life, and Personality. An Examination of the Mechanistic Theory of Life and Mind. By J. S. HALDANE, M.D., LL.D., F.R.S. 2nd Edition. (John Murray, 6*s.*)

Botany with Agricultural Applications. 2nd Edition. By JOHN N. MARTIN, Ph.D. (New York: John Wiley & Sons; London: Chapman & Hall, 21*s.* net.)

Orographical, Regional, Economic Atlas. Part III, Asia. Editor, THOMAS FRANKLIN. (W. & A. K. Johnston, 1*s.* 6*d.* net.)

The Encyclopædia and Dictionary of Education. Part I. Edited by PROF. FOSTER WATSON, D.Litt. (Sir Isaac Pitman, 2*s.*)

The Somatic Organisation of the Phæophyceæ. Botanical Memoirs, No. 10. By A. H. CHURCH. (Oxford University Press, 5*s.*)

The Theory of Relativity. By PROF. R. D. CARMICHAEL. (New York: John Wiley & Sons; London: Chapman & Hall, 6*s.* net.)

Why Do We Die? By T. BODLEY SCOTT, M.R.C.S. (T. Fisher Unwin, 5*s.* net.)

Principles and Methods of Industrial Education. For use in Teacher Training Classes. By WILLIAM H. DOOLEY, with an Introduction by CHAS. A. PROSSER. (Harrap & Co., 6*s.* net.)

Principles of Human Geography. By ELLSWORTH HUNTINGTON and SUMNER W. CUSHING. (New York: John Wiley & Sons; London: Chapman & Hall, 21*s.*)

Insect Life. By C. A. EALAND, M.A. (A. & C. Black, 30*s.* net.)

Germination in its Electrical Aspect. By A. E. BAINES. (Routledge, 12*s.* 6*d.* net.)

Wireless Telegraphy. The Directly-Useful Technical Series. By BERNARD LEGGETT, A.M.I.E.E. (Chapman & Hall, 30*s.* net.)

Nile and Jordan. An Archæological History of the Interrelations between Egypt and Palestine from the Earliest Times to the Fall of Jerusalem in A.D. 50. By G. A. F. KNIGHT, M.A., F.R.S.E. (James Clarke & Co., 36*s.* net.)

The Lands of Silence. A History of Arctic and Antarctic Exploration. By SIR CLEMENTS R. MARKHAM, K.C.B., F.R.S. (Cambridge University Press, 45*s.* net.)

The Practical Electrician's Pocket-Book. (S. Rentell & Co., 3*s.* net.)

Belgium. From the Roman Invasion to the Present Day. By EMILE CAMMAERTS. The Story of the Nations Series. (T. Fisher Unwin, 12*s.* 6*d.*)

Studies in Trench Forestry. By THEODORE S. WOOLSEY junior, with two Chapters by WILLIAM B. GREELEY. (New York: John Wiley & Sons; London: Chapman & Hall, 36*s.*)

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